AN ABSTRACT OF THE THESIS OF

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Title: Boating in Alaska's Prince William Sound: Modeling and Assessment of Recreational Use

Abstract approved:

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This study measures the recreational boating use in Prince William Sound, Alaska. Improved access conditions to the Sound over the last decade coupled with a statewide increase in outdoor recreation participation among both resident and out of state tourists have made the Sound a focal point for recreational boating in Alaska. The goal study is to provide baseline data for future assessment of recreational use in the Sound and evaluation of management issues. A primary objective is to determine the type of users, level of use and spatial distribution of recreational use in the Sound. Accurate information on visitor use aids management with a particular emphasis on maintaining the wilderness quality as well as providing ecological protection throughout the Sound. As such, a second objective of this study is to determine the potential interactions between recreation use and five wildlife species which aids in the mission of the recovery of the Sound from the *Exxon Valdez* oil spill. A large marine environment with highly dispersed recreation use, however, poses difficulties in applying conventional methods of visitor monitoring and identifying where potential conflicts may occur. This study is the first to address recreational use across the entire Sound by employing recreational modeling techniques. Survey participants provided mapped travel diaries detailing the location of their stops and the various activities in which they participated. These diaries were digitized and analyzed using GIS.

A total of 2085 surveys were distributed with a 27% sample rate and 31% return rate. Results indicate that use levels are highest in the western portion of the Sound. Nearly 75% of trips reported participating in water-based activities. Rates of

participation in recreational activities varied based on vessel type. Although land-based activities were reported relatively infrequently, their location and impact on the Sound are of significant interest to the Chugach National Forest. Recreation use in proximity to known wildlife sites was limited. Several areas such as Naked Island and Dutch Group, however have a high concentration of both black oystercatchers and pigeon guillemot nest sites and relatively high visitor use associated with them. Results of this study are intended to aid in the development of a framework, at an appropriate scale, to manage the future growth of recreation use in the Sound.

Boating in Alaska's Prince William Sound:

Modeling and Assessment of Recreational Use

by

Phillip E. Wolfe

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I understand that my thesis will become part of the permanent collection at Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Phillip E. Wolfe, Author

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Chapter 1 Introduction

Prince William Sound is a large embayment of the northern Gulf of Alaska that covers over 4,000 square miles. It is host to a number of different activities ranging from commercial fishing to the transportation of crude oil to an assortment of recreation possibilities. The Sound, which is surrounded by lands managed by the Forest Service, the State of Alaska and native corporations, is expected to see an increase in outdoor recreation from both residents and out-of-state tourists. Outdoor recreation by Alaskan residents is expected to increase by 30% between 2000 and 2020 (Bowker 2001). The complexity of this large marine environment requires managers to balance several different issues, ranging from wildlife habitat conservation to visitor use and their interactions, when making management decisions. This report is part of the ongoing Prince William Sound Human Use Study and focuses on the recreation use that occurred during the summer season of 2005 (May-September) in Prince William Sound.

Recent changes in access to the Sound, such as the opening of the Whittier Tunnel to automobile traffic in 2000, have made it considerably easier for visitors to access the port in Whittier. Furthermore, in 2006 it became much easier to travel between the towns of Cordova, Whittier and Valdez when the Alaska Marine Highway System implemented new sailing routes in the Sound. Hypothetically, these changes may have considerable impacts on the dispersal patterns of users in the Sound.

Humans have inhabited Prince William Sound for thousands of years, forming close relationships with the land that continues to this day. Recently this was evident when hundreds of Alaskans helped recovery efforts in the aftermath of the *Exxon Valdez* oil spill. Thus public sentiment regarding the management of this resource is perceived to be high. As such, management decisions need to be articulated and transparent and should be based on the best available information regarding the resource. Past studies of recreational use have focused on the more heavily used western portion of the Sound. This study is the first to address visitor use across the entire Sound. The results presented in this study are intended to aid in the

development of a comprehensive monitoring plan for the recreational boat use in the Sound as well as provide guidance for future studies.

Land managers of Chugach National Forest, which manages a vast majority of the land in the Sound, expressed interest in documenting human use throughout the Sound. The purpose of this study is to document the distribution of human use and the associated impacts within Prince William Sound. As a result, this study has two primary objectives.

- The first objective is to determine the types, distribution and seasonal variation of human use in the Sound.
- The second objective is to determine the proximity of human use in previously identified wildlife areas in the Sound.

Objective 1 provides a seasonal (Early, Core, Late) evaluation of where visitors disperse across the Sound. While the total number of trips has been shown to have some correlation to impact, this study evaluates the activities participated in during trips as well as the total number of trips and travel mode. The second objective addresses the potential interactions between humans and wildlife and directly relates to the mission of the recovery of the Sound from the *Exxon Valdez* Oil Spill. Five species were analyzed (Bald Eagles, Black Oyster Catchers, Harbor Seals, Cutthroat Trout & Pigeon Guillemot) to determine the interaction of recreational activities on known rookeries and spawning sites of these species.

To address both objectives, this study integrates primary data collected on the recreation use of the Sound with existing data on the locations of sensitive wildlife areas in a GIS framework. A survey instrument was developed that consisted of two separate sections; a text-based behavioral portion focusing on participants' general use history and patterns, and a trip/diary portion, which focused on the spatial distribution of participants' current or most recent trip. Respondents of the survey provided a detailed map diary of their recreational boating trip in the Sound, including information on the location of their stops and the activities they participated in at each

stop. These data were then incorporated with existing wildlife data in order to determine the proximity, and type, of recreational use near wildlife nesting sites.

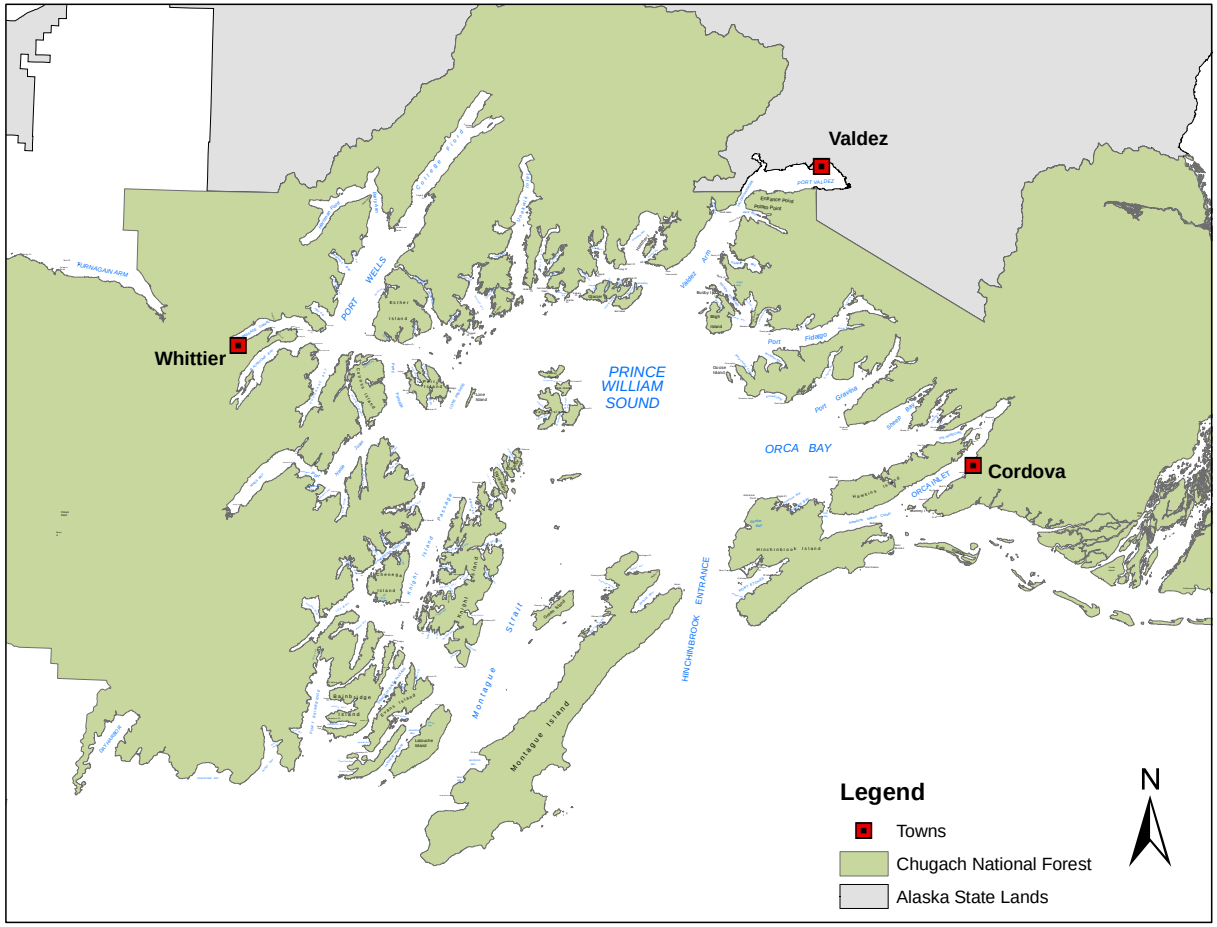


Figure 1: Overview map of study area

Chapter 2 Review of Literature

This literature review was developed to illustrate the tools employed to design, implement and interpret this study on recreation use in Prince William Sound. The results of this study are also intended to aid in the creation of a monitoring plan as well as provide recommendations for future studies addressing recreation use in Prince William Sound.

In order to discuss recreation use and the associated management concepts we will begin by examining the various fundamental ideas that are common and integral in the recreation literature. This study provides a baseline model of the spatial use that occurred during the 2005 use season; thus, a review of the spatial modeling literature will be presented.

2.1 Wilderness History and Management

The Wilderness Act was passed by Congress in 1964 and established the National Wilderness Preservation System (NWPS). Initially, only 54 U.S. Forest Service (USFS) areas were included. By 2000, over 600 areas were included; totaling over 104 million acres managed by the USFS (Meyer, 2000). Wilderness is defined as an "area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain" (Wilderness Act §2(c)). Although Prince William Sound is not designated as a Wilderness area, the Chugach National Forest manages it as *de-facto* wilderness (USDA Forest Service, 2002). More than 1.4 million acres, or 54% of the Sound, are currently designated as Recommended Wilderness (CNF-Management Plan, 2002). This will be discussed in greater detail below.

As Cole (2001) points out there are two dilemmas managers face when attempting to manage for the Wilderness Act. The first dilemma involves finding a balance between providing access to the area for "use and enjoyment" and protecting the biophysical conditions that constitute the wilderness. The second dilemma involves "conflict between two desirable attributes of wilderness ecosystems:

wilderness, the lack of intentional human manipulation; and naturalness, the relative lack of human influence" (Cole, 2001, p.5). In order to aid in the management of wilderness areas several different management frameworks have been established. Shelby and Herberlein (1986) developed the Carrying Capacity Assessment Process (CCAP) which is intended to assist managers in defining appropriate visitor carrying capacities for an area. Hof and Lime (1997) discuss the difference between the Visitor Experience and Resource Protection (VERP) framework, which was developed for the National Parks Service, and the Limits of Acceptable Change (LAC), which was published by the Forest Service in 1985. The Recreation Opportunity Spectrum (ROS) segregates areas based on opportunity classes delineated by levels of use and levels of accessibility. The LAC and ROS frameworks are implemented to varying degrees by the Chugach National Forest and therefore will be discussed in greater detail below.

2.2 Carrying Capacity

Recreation use levels are often addressed using the carrying capacity concept. The concept is discussed in detail by Shelby and Herberlein(1986) and has since been refined by others. Shelby and Heberlein categorized carrying capacity into four dimensions; Physical, Facility, Ecological and Social. The primary focus for this study will address social carrying capacity; the other three will be reviewed briefly. However, as recreation is predicted to increase in the Sound, and as we learn more about users of the Sound, the other dimensions of carrying capacity may become threatened in localized areas.

A brief discussion of what is required to establish these various carrying capacities is warranted. Shelby and Herberlein discuss using both descriptive and evaluative components in order to determine a carrying capacity. The descriptive component addresses how a recreation system works. For example, 100 boats leave the harbor in Valdez and participate in various activities in the Sound. The next component includes the management parameters that can be manipulated. These parameters may include varying use levels, reducing the number of boaters allowed to

launch in Valdez, or perhaps staggering launches of the 100 boaters across the entire day. The final descriptive component involves the impacts to the recreation system caused by the type and amount of use. The type of impact then determines whether it is an ecological, physical, facility or social carrying capacity.

The evaluative component defines what recreation opportunities the specific system should provide as well as determining the point at which the impacts are too great. The first component involves defining the type of experience by specifying the management objectives. For example, a management objective for the Sound could be to provide solitude while fishing. The final component, the evaluative standard, then specifies the levels in terms of minimum, maximum and optimum. Continuing with the previous example, the optimum number of encounters for providing solitude for anglers may be one, while the maximum might be four.

The descriptive and evaluative components combine to provide insight into determining a specific carrying capacity. Therefore, information on the system, users, and users' values of the Sound is necessary for developing efficient, effective and socially acceptable management prescriptions.

The Four Different Types of Carrying Capacity:

Physical carrying capacity deals with how much space is actually available. An example would be the amount of adequate flat space required for a tent. The principle idea being that in a natural setting, the amount of space is fixed; thus, the only way to increase the physical carrying capacity would require management parameters to be changed in order to use the space more efficiently.

Facility carrying capacity is concerned with improvements that are made in order to address visitor needs. Examples include parking lots, restrooms and boat ramps. Each of these facilities has a limited number of visitors it can support. For example, a parking lot can only hold as many cars as there are parking spots. Facility capacity may be increased by adding more parking spaces.

Ecological carrying capacity deals with the impacts on the ecosystem. Examples of ecological carrying capacity include the effects of use on plants, animals

as well as water and air quality. Active management can address and work towards limiting these impacts in several ways. As Shelby and Herberlein (1986) point out, "an agency could require users to carry out their waste, thus reducing the impact on the ecosystem without limiting the number of visitors" (p.19). Or management may require camping in designated areas only, confining impacts to a specific area/place.

Social carrying capacity addresses the level, or number of visitors, that are acceptable for a given area based on visitor preferences and expectations. Beyond these preferred levels the experience is altered, generally in a negative fashion. Shelby and Herberlein state that "Social carrying capacity is the level of use beyond which social impacts exceed acceptable levels specified by evaluative standards." (p21). Establishing a metric to determine social carrying capacity requires three conditions are met.

Rule 1: To establish social carrying capacity, there must be a known relationship between use level or other management parameters and social impacts.

Rule 2: To establish social carrying capacity there must be agreement among groups about the type of recreation experience to be provided.

Rule 3: To establish social carrying capacity there must be agreement among relevant groups about the appropriate levels of social impact. (Shelby and Herberlein, 1986, p21-22)

Rule 1 is concerned with the descriptive component in defining how the management parameters are related to the specific impacts of concern. If the managing agency were to allow 100 boats to launch from a specific harbor they can determine what the impact will be on number of encounters among the boaters. Identifying this relationship is the basis of rule number one.

Rule 2 addresses how the management objectives must specify the specific experience that is to be provided. For example, if the objective is to provide for abundant fishing opportunities there may be conflict if users want to water ski in the same area. In order to determine the proper social carrying capacity there needs to be agreement as to what type of experience will be provided.

Rule 3 is specific to the evaluative standards. Continuing with the fishing example, we also would need to understand whether anglers in general desire solitude while fishing or whether fishing is a social event. If there is a high degree of agreement among users, it is possible to determine a social carrying capacity. However, if there is little agreement and some anglers prefer to fish in large groups while others seek solitude, then the ability to determine social carrying capacity is limited.

2.3 Management Frameworks Employed in Prince William Sound:

Chugach National Forest (CNF) managers rely on various frameworks to guide them through the recreation management process. Both the Recreation Opportunity Spectrum (ROS) and the Limits of Acceptable Change (LAC) frameworks are used in various capacities and will be discussed in this section in order to provide context for the results of the study. Overall, Prince William Sound is designated a national forest; however, certain areas within the Sound have received special designation such as Recommended Wilderness areas. As a result, the CNF attempts to manage the entire sound as if it were a wilderness area. (USDA Forest Service, 2002)

Recreation Opportunity Spectrum (ROS)

The Recreation Opportunity Spectrum presumes that recreationists seek a broad range of recreation experiences and thus is designed to provide for as many of these settings as possible. Wagar (1964) was one of the first researchers to discuss the fact that recreationists desire a wide range of facilities while participating in recreation. A continuum of six different classes identified in ROS was described by Brown et al. (1978) and Manning (1999) and is presented in the table below.

Table 1: Recreation Opportunity Spectrum use classes

Opportunity Class	Experience
Primitive (P)	Opportunity for isolation and a high degree of challenge
Semi-Primitive Non-Motorized (SPNM)	Opportunity for isolation and a moderate degree of challenge- No motorized use
Semi-Primitive Motorized (SPM)	Opportunity for isolation and a moderate degree of challenge- Motorized use
Rustic (R)	Opportunity for both isolation and contact with other user groups. Challenge not important. Both motorized and non-motorized use.
Concentrated (C)	Contact with other user groups is common. Convenience is important. Challenge is not important.
Modern Urbanized (MU)	Contact with other groups is common. Convenience is important. Interaction with natural surroundings is unimportant. Challenge is not important.

Similar to the six ROS classes, the Chugach National Forest has developed five prescription categories for the forest. These different management prescriptions range from (1) little human influence to (5) long term human influence. In Prince William Sound, only the first three prescription categories are utilized, leading to *de facto* management of the Sound as a wilderness area. All five prescription categories are discussed below.

Category 1 allows ecological processes such as fire, insects and disease to operate relatively freely. Areas designated in this category are intended for users who are self-reliant and will have little contact with other groups or people. In general, no facilities are present and travel is non-motorized. A total of 1,412,230 acres, or 54%, of the Sound are included in this category.

Category 2 allows for limited direct influence by humans on ecological processes. Habitat manipulation for the conservation of species may occur in these areas. Overall human use is limited and generally not intense. Both motorized and non-motorized vessels are allowed. Finally, cabins and other built features may be present. A total of 1,113,000 acres, or 42%, of the Sound are included in this category.

Category 3 allows for ecological processes to occur but takes into consideration human occupancy. Habitat manipulation occurs on a limited scale;

however natural processes dominate such that the landscape has a natural appearance. Visitors experience isolation from sight and sound of other humans and can expect a limited amount of challenge and risk—although challenge and risk in the Sound is relative. A higher degree of motorized travel is allowed in these areas but may be restricted by season or in specific locations. A total of 5,510 acres, or 0.2%, of the Sound are included in this category.

Prince William Sound does not have any land that is designated in the remaining two categories and therefore will not be discussed in detail. However, both of the remaining prescription categories allow for a greater degree of ecological manipulation and human presence. Visitors to these areas should expect a higher degree of contact with other visitors as well as seeing motorized use frequently. A majority (96%) of the land in PWS is designated in prescription categories 1 and 2, which allow for little human influence while allowing ecological processes to proceed naturally. Overall, the management prescriptions for PWS are geared towards maintaining a wilderness setting.

The ROS attempts to provide recreation opportunities to visitors with a variety of value systems; however, this can sometimes result in conflicts arising between users (Brown et al. 1978; Clark and Stankey 1979). One group of users may seek a primitive type of experience while on their trip in the Sound, while another group may desire an experience with the amenities of a more developed type of experience. For example, visitors using either sea kayaks or sailboats may desire that their trip be void of non-natural sounds such as motors. They may seek to distance themselves from other groups with motorized vessels. Another group using a large motorized vessel may desire a more developed type of experience allowing them to visit a variety of different locations for different purposes. This group may not be as sensitive to non-natural sounds since they are actively participating in producing these types of sounds themselves.

Conflicts may occur when one group is more sensitive to an issue such as noise than another group. This type of conflict is referred to as an asymmetric relationship.

This concept originated in the social psychological field and was first demonstrated by Newcomb (1956). Adelman et al. (1982) found asymmetrical antipathy occurring between paddling canoeists and motorcraft users in the Boundary Waters Canoe Area. They concluded that the motorcraft users were not aware of how the paddling canoeist perceived them. Furthermore, they stated that the asymmetrical antipathy would continue as long as the motorcraft users were unaware of how the paddling canoeist truly felt about them. While similar conflicts may be occurring between paddlers and motorized vessel users in Prince William Sound, this study does not address this issue specifically.

Visitors to an area arrive with different expectations about the type of experience they hope to obtain, and it is often difficult to manage for all these different experiences. Manning (1999) discusses how managing for the mean recreation experience is ineffective and would result in a lower quality experience for all user groups. In order to alleviate possible conflicts between users with different goals, the concept of 'zoning' has emerged as a tactic. There are two different forms of 'zoning' used by recreation managers. The first is to zone by time. This can be done on a small scale such as several hours, or at a larger scale such as an entire season. For example, if motorized use conflicts with non-motorized use in an area, managers may decide to allot certain times when motorized use may occur and others when no motorized use is acceptable. The second method of 'zoning' involves separating users in space; i.e., create areas where activities are and are not allowed. Continuing with the motorized and non-motorized example, managers could designate certain areas for each type of use.

As with the previous examples, the users in the example all had certain expectations about the type of recreation experience they were seeking. Norms are the basic values that people hold. Several authors (Heberlein 1977, Shelby and Herberlein 1986) have refined work done by Jackson (1965) who developed a methodology for measuring norms. The resulting normative theory attempts to organize these concepts for outdoor recreation and management. Visitors can be asked to evaluate alternative

scenarios based on a variety of different recreation situations. When consistency is found among users' values, they result in "rules" about how things should be for a given situation. For example, a fishing experience in the Sound may be defined by solitude and a lack of human-caused noise by many visitors. This "rule" could be violated if a group that has been fishing in a location in solitude is joined by another group that not only lessens the amount of solitude but perhaps also creates abundant noise. When violations of norms occur users generally employ a variety of coping mechanisms. This will be discussed in greater detail in section 2.4.

Limits of Acceptable Change:

The Limits of Acceptable Change (LAC) management framework revolves around determining impacts to social and biophysical resources. As opposed to other frameworks that ask "how much use is too much", the LAC model focuses on determining "how much change is acceptable" (Stankey et al., 1985, p. 157). LAC is a continuous, multiple-step process. The first stage of the process is to properly identify the issue or concerns about the resource. This is a means of bringing together all of the different stakeholders involved. Similar to the ROS, stage two is concerned with defining opportunity classes based on activities, experiences and settings. Stages three and four involve selecting and measuring the social and biophysical indicators. As discussed by Manning (1999) these indicators must be specific, and quantifiable. Examples of biophysical indicators include trail erosion and the amount of bare soil at campsites. Social indicators include the number of encounters and the amount of noise experienced. Stage five involves specifying specific standards for both the biophysical and social indicators. Marion et al. (1985) remind managers to adhere to caution when setting standards because they represent the upper limit of acceptable change. Due to this, efforts should be made to ensure that the actual resource conditions do not deteriorate to the specified limit. Stage six should ask for input from both the public and managers in determining what resources and social conditions should be monitored or achieved for a specific area. This stage asks managers to evaluate their resource and determine which of the different opportunity classes they

wish to provide. As Hendee (1990) points out, managers may decide only to only manage resources for a few of the opportunity classes---the other classes may be present elsewhere in the region. Stage seven identifies the differences that may exist between the current conditions of the resource and the conditions specified in stage five. This practice identifies areas where the resource conditions are not optimal and provides managers with information on what kind of management actions may be required. Furthermore, Hendee (1990) states that "By maintaining conditions better than the standards required, further diversity in conditions is achieved." (Hendee et. al., 1990, p.228).

Stage eight involves evaluating and selecting the preferred management alternatives that reflect the objectives of the stakeholders who are involved. During this process the cost and benefits should be evaluated in order to determine which management alternative is "best". Once the preferred management alternative has been implemented, stage nine calls for developing protocol to establish proper monitoring of the specified indicators. The monitoring protocol should be articulated such that indicators can be measured as well as determining how often monitoring will occur and by whom. In the LAC framework this is not the final stage, instead the LAC framework is dynamic and circular in nature; i.e., the process should be ongoing and begin again at stage one.

2.4 Coping Mechanisms: Substitution, Displacement and Product Shift.

Even without managerial interference, people have found different means of addressing and dealing with a variety of issues relating to their recreation experience. Coping mechanisms such as substitution, displacement and product shift have been employed by visitors in order to maintain their level of satisfaction with the recreation experience. Recreation managers and researchers have long struggled with determining a concise measure of user satisfaction. According to Jackson (1989), satisfaction can be divided into "internal factors" and "external factors". Internal factors are shaped by motivations, attitudes, and past experiences, all of which managers have little control over. Nevertheless, managers should be aware of why

visitors are participating in particular activities. External factors are attributes "summarized in the amount, location, design, quality, management, and use of recreation resources, facilities, and programs" (Jackson, 1989, p. 118). Recreation literature has identified several different methods that people use as coping mechanisms, in turn allowing them to maintain a high level of satisfaction.

Substitution: Hendee and Burdge (1974) first defined the phenomenon of substitutability, in recreation management literature, as "an interchangeability among activities in satisfying participants' motives, needs and preferences" (p.157). The literature has typically focused on comparing similar activities such as goose hunting and deer hunting; however, as the phenomenon was better understood, research began focusing on specific types of substitution. Shelby and Vaske (1991) defined five substitute categories: *strategic*, when visitors seek a alternate means of gaining access to the same activity; *temporal*, where the original activity is maintained but a change in timing occurs; *resource*, when a new setting is found for the original activity; *activity*, where the original activity is surrendered and the user participates in a new activity at the original location; and *resource and activity*, where the user participates in a new recreation activity in a different location. Shelby and Vaske point out that visitors prefer substitutes that will maintain as many features as possible of the original experience.

Displacement: Is a specific type of substitution, defined by Hall and Shelby (2000) as a response to "a perceived adverse change at a recreation site that causes its visitor to change their behavior" (p.436). Different from other forms of substitution, here they key is that recreationists alter their behavior in response a negative evaluation of the original, or intended, recreation site. The concept revolves around the fact that recreationists will change their experience by one or more of the following: timing, location of access, setting and/or the activity. For example, a change in timing could occur if visitors determine that a boat launch facility is too crowded for them, thereby returning at a later time when there is less traffic. This temporal change could occur by visitors choosing to participate in their original

activity at a different time of the day, day of the week, or even season (e.g., moving to off-peak season use). If a secondary, less used boat launch facility is available they may choose to change how they access the recreation site. This would be considered an intra-site displacement. Conversely, an inter-site displacement would occur if visitors choose to participate in their original activity at a completely different location. Finally, some visitors may choose to alter their original activity, and instead of boating they may choose to participate in hiking.

Product Shift: Where displacement produces a change in visitor's behavior, product shift is a "cognitive strategy involving changing the label applied to the experience" (Shindler and Shelby, 1995, p.93). A panel study conducted by Shindler and Shelby (1995) of users who floated the Rogue River in south western Oregon in 1977 and again in 1991 found that even though use levels were increasing, visitors were more likely to change their experience definition than to become dissatisfied. Furthermore, their study found that users change their experience definition towards a higher density experience, and that while the number of encounters on the river increased, their perceived crowding did not change. They conclude by pointing out that product shift occurs by default rather than by design, indicating that resource managers have little control of the products they are offering. In the case of Prince William Sound, as use levels are expected to increase in the coming years (Bowker, 2000), it is important that the resource managers be aware of phenomena, such as product shift. As Shindler and Shelby (1995) point out, "Systems that define the scope of recreation opportunities and outline specific experiences can play a major role in combating product shift." (p.105).

2.5 Recreation Effects on Resources and Wildlife

Critical to this study is the use of GIS technology combined with the ability to model recreation use in Prince William Sound. Our study uses these techniques to evaluate mode of travel, destination and frequency of visit, all of which are useful in the study of human impacts on wildlife (Cole 2004) and the impacts that human activities have on wildlife and their associated habitats (Steidl & Powell 2006). Cole

(2004), Blahna & McCool (2004) and Manning & Lime (2000) all agree that recreation use is dispersed unevenly across the landscape. The uneven distribution of recreation users combined with the size of PWS emphasizes the need to effectively collect spatial and temporal visitor data to empirically derive distributions across a landscape. Manning and Lime (2000) suggest "that increasing wilderness use can and often does increase impacts in the form of damage to fragile soils and vegetation, and crowding and conflicting uses." However, the critical point at which a threshold is reached between visitor use levels and biophysical impact is not known. Cole (1993) and Blahna & McCool (2004) have both illustrated that the relationship is not linear. In fact, what they show is that biophysical impact occurs at a much higher rate as visitor use levels increase and at some point, use levels plateau showing very little additional increase in impact. Cole (2004) suggests that "relatively infrequent and small amounts of use can cause substantial impacts." Hammitt and Cole (1998) suggest that at "low frequencies, small differences in use frequency can result in substantial differences in the amount of impact. At high use frequencies, even large differences in use frequency typically results in minor differences in impact."

2.6 Spatial Modeling for Recreation Management Research

This section illustrates the history and current use of spatial modeling programs in relation to recreation and resource management. Modeling recreation use has the ability to provide specific and detailed information on current use patterns for a given recreation area. Probabilistic simulation modeling can be used as an inexpensive means of examining recreation use under different management scenarios. This is particularly promising since managers have the ability to examine use under various management alternatives prior to actually implementing them.

2.6.1 History of Recreation Modeling

Resource managers are often faced with the task of protecting resources while providing high quality recreation experiences. Although an understanding of the recreational users' trends provides land managers with valuable guidance while making management decisions, the lack of specific information on current visitor use

can be a limiting factor. As Cole et al. (2005) points out, "Because our political environment demands ever more reliance on scientific data and transparent decisionmaking, planners and managers need better tools to help them understand current visitor use, analyze potential alternatives for future use, and communicate the implications of various alternative decisions in ways that are meaningful to the public." (p.1). Cole continues by stating that in order to answer many of the management questions, an understanding of temporal and spatial distributions of visitor use is fundamental. Some of the earliest attempts at modeling recreation use were conducted by International Business Machines (IBM), Resources for the Future, and the USFS. In the early 1970s they developed the Wilderness Use Simulation Model. This model was based heavily on the hypothesis by Stankey (1972) that visitor's satisfaction in a wilderness experience is inversely related to the number of encounters with members of other parties. However, the model lacked the ability to track the number of encounters between parties.

In 1973, the General Purpose Simulation System (GPSS), the next generation of recreation modeling began development. In 1976, Smith and Krutilla used the prototype of GPSS in the Spanish Peaks Primitive Area and the Adirondack Forest Reserve. The model replicated the area's travel network, its entry points and campsites locations. The ability to keep track of the number of parties and their travel routes in the simulation allowed for the tracking of the number of encounters occurring between parties, including differentiating between simple meetings or overtaking encounters on the trail and if encounters occurred in camp.

Several suggestions for modifications were made based on the results of the Smith and Krutilla study. One of the suggestions was to include the ability to track visible encounters, when two parties are close enough to see each other but are not on the same trail or in the same campsite. These suggestions were incorporated in a new model that was used in the Desolation Wilderness in California by Shechter and Lucas (1978). The authors conclude that the data collected about the area and the resulting modeling would be of substantial benefit when making management decisions. The

same model was used in Yosemite National Park with particular focus on campsite encounters. Absher and Lee (1981) hypothesized that the nature and location of the encounter had a larger effect than the number of encounters. Also, when users expect to meet other parties they perceive the encounter to have less of an impact on their experience than when an encounter occurs where none are expected.

The model was adapted for use in river settings and applied to the Green and Yampa Rivers in Dinosaur National Monument (Lime et al. 1978). A river provides a unique corridor through a wilderness area with limited entry and exit locations. Users are only able to travel in one direction and the rate of travel is largely determined by the flow of the river. The authors of this study concluded that simulating use on the river provided a powerful aid to river management planning. They were able to simulate the effects of different launch dates and times at each of the launch sites, allowing them to see the effects of their actions before actual implementation occurred. The ability to model recreation use in this manner provided a means for evaluating management alternatives that is considerably cheaper than the traditional trial and error methods. For a comprehensive review of the development of recreation modeling, please refer to chapter 2 of Cole et al. (2005).

2.6.2 Current Modeling and Simulation Programs

The use of simulation programs in wilderness areas was an expensive undertaking in the 1970s and early 1980s. Subsequently, the difficulties and price of running these models limited the implementation of the Wilderness Use Simulation Model and GPSS. In the 1990s, with the increase in personal computer processing speeds, a renewed interest in modeling surfaced. Currently there are two primary modeling programs that are able to run inexpensively on personal computers. The modeling program Extend (1996) was developed to address carrying capacity issues in National Parks. This software uses probabilistic simulation models in which groups are assigned entire travel routes (Cole, 2005). Extend has been used to simulate a variety of different situations including frontcountry hiking (Lawson and others 2002) and in backcountry camping (Lawson and Manning 2003a,b).

Gimblett and Itami developed the Recreation Behavior Simulation that uses rule-driven autonomous agents together with a geographical information system (GIS) to simulate recreation behavior (Gimblett et al. 2001, O'Connor et al. 2005). This combination provides a modeling program with an extensive spatial component that is ideal for modeling human/landscape interactions. Rule-driven autonomous agents have the ability to simulate behavior of individuals based on behavior "rules" that can be derived from observations, interviews and/or surveys of the visitors in an area. Since RBSim employs rule-based simulations together with probabilistic simulations, it has the ability to be used in a variety of different situations and for different purposes. The Prince William Sound Human Use Study is a multi-year project that includes several ongoing studies. As discussed previously, the intent of this thesis is to demonstrate visitor use conditions of the 2005 summer use season. The results presented here are intended to help guide ongoing and future studies in determining the specifics of recreation use in Prince William Sound. One of the overarching objectives of the PWSHUS is the creation and implementation of a robust modeling program in order to address a variety of management issues and concerns. For the attributes discussed above, RBSim was selected because it combines rule-based and probabilistic simulation as well as its ability to represent the human/landscape interactions.

As the Chugach National Forest is expected to see an increase in use in the future, the ability to accurately simulate and model recreation use becomes increasingly important. The resulting type and distribution of human use will have tremendous impacts on how the Sound should be managed in order to balance maintaining wilderness, protecting wildlife habitat and providing recreation opportunities. The use of a comprehensive simulation modeling program will provide a tool for land managers to evaluate management decisions before implementing them, or to identify potential areas of concern based on carrying capacities, management prescriptions, and changing resource conditions and use levels.

2.7 Summary

This chapter began with a discussion of Wilderness including its history and some of the issues managers face while making management decisions. Managers are charged with providing a high quality recreation experience while at the same time protecting the resource. In order to guide managers, researchers have developed several management frameworks. A brief review of the carrying capacity model was included and set the stage with a discussion of the fundamental concepts in the recreation literature.

This review continued with a discussion about current management frameworks employed by the Chugach National Forest. Both the Recreation Opportunity Spectrum and the Limits of Acceptable Change frameworks were presented in the context of management issues in the Sound. The need for detailed descriptive information to guide management decisions was addressed along with a discussion of visitor use behavior as related to wilderness. Coping mechanisms employed by visitors such as substitution, displacement and product shift were presented in order to illustrate the complex issues resource managers are faced with.

Although understanding visitor behavior and trends provide valuable information that can help guide management decisions, there is a general lack of specific information regarding current visitor use of the Sound. Simulation and modeling of recreation use is a means of linking management with probable outcomes; thus, a review of these types of models was provided. In particular, reasons for selecting and implementing the RBSim were discussed in the context of the Sound. This chapter laid the groundwork for the discussion of the current visitor use patterns in Prince William Sound as well as sets the stage for future studies aimed at addressing specific management issues.

Chapter 3-Study Area and Research Design

This chapter provides an overview of the study area and the research design used in the Prince William Sound Human Use Study. The following sections will focus on describing the study area, how and where visitors access the Sound, including changes in access conditions. The latter portion of this chapter will discuss how the survey was designed as well as data collection procedures.

3 .1 Study Area

Prince William Sound is a large marine ecosystem located in the northern Gulf of Alaska. The Sound encompasses an area of over 4,000 square miles and contains numerous fjords and islands. The over 3,000 miles of shoreline are often rocky and quite steep, which limits access to land. Waters of PWS are generally over 200 meters deep, even within many of the bays. The climate of the region during the summer recreation season consists of cool temperatures with frequent precipitation, some overcast fog and strong winds. Numerous tidewater glaciers calve during the early portion of the season, filling bays and some areas of the Sound with icebergs. The region is well known for its commercial fishing and crude oil transport; however, tourism and recreation activities are increasing with commercial sightseeing tours, cruise lines and sea kayak rental shops becoming abundant in the area.

Although the use and population of Prince William Sound is increasing, it retains its outstanding wilderness characteristic. As discussed in the previous chapter, the Chugach National Forest is actively managing the Sound to maintain its wilderness characteristics. Suring et al (2004) discuss land ownership in the Sound. They begin by stating that the Chugach National Forest manages the largest amount of land within the study area (4,160 km^2); while the State of Alaska manages an additional 183 km^2 of land within the Sound. Additionally, the Alaska Department of Natural Resources manages most of the submerged and tidal lands up to the mean high tide mark within the Sound. There are several different native corporations who own approximately 265km^2 of land in the Sound and manage the land independent of the Forest Service's

regulations. Finally, there is limited private ownership of lands outside of the communities in the Sound; these parcels however do not exceed 6 km^2 in total.

3.1.1 Access points to the Sound

There are three primary access points to Prince William Sound. Whittier, with a population of 182, is located in the north western portion of the Sound. Due to its proximity (approximately 62 miles by road) to Anchorage, it has the highest amount of use associated with it. The town is a result of various government projects, many of which were built by the US Army during World War II. Prior to 2000, access to Whittier via land was limited to transport by train. With the opening of the Anton Anderson Memorial Tunnel, commonly referred to as the Whittier Tunnel, automobile access to Whittier became considerably easier. The impacts of opening the Whittier Tunnel will be discussed in greater detail in section 3.1.3 that examines the changes in access conditions to the Sound.

Valdez, with a population of just over 4,000 individuals, is located in the north eastern portion of Prince William Sound. In the late 1800's a pack trail connected Valdez to Eagle and Fairbanks. This pack trail eventually became the Richardson Highway and now connects Valdez to the rest of Alaska. The highway is now used by people who wish to spend time in Valdez and experience Prince William Sound, particularly residents from Fairbanks, Alaska's second largest population center. Valdez also hosts the Valdez Marine Terminal, which is the southernmost end of the 800 mile long Trans Alaska Pipeline. It was here that the *Exxon Valdez* supertanker filled with oil before embarking on its infamous journey that resulted in it running aground at Bligh Reef and spilling millions of gallons of Prudhoe Bay oil into the Sound. This event and the resulting damage to the ecosystem of the Sound will be discussed in greater detail in Chapter 7.

Cordova, with a population of approximately 2,500, is located in the south-eastern portion of Prince William Sound. There are no roads that connect Cordova to the rest of Alaska; as such the only means of accessing it are by airplane or by boat. Most visitors either arrive by airplane, via daily commercial service from Seattle,

Anchorage and Juneau, or by using the Alaska Marine Highway ferry system. The ferry allows visitors to transport their vehicles to and from Cordova. The impact of the ferry system will be discussed in greater detail in section 3.1.3 that addresses the changes in access conditions to Prince William Sound.

3.1.2 Increased recreation use in Prince William Sound

Several studies have examined outdoor recreation trends in Alaska. Bowker (2001) shows participation and intensity rates of recreation among Alaskans are higher than for residents of other states. He continues by including fishing in a list of activities with the highest annual participation per capita of Alaskan residents. Finally, he concludes by indicating that these trends will continue through 2020. Another study by Brooks and Haynes (2001) points out that there has been steady growth in the number of nonresident fishing licenses sold. Furthermore, activities such as viewing wildlife and scenery are among the fastest growing in the state of Alaska. Since, as we will demonstrate in this thesis, these activities, particularly fishing, are popular in Prince William Sound, we can expect to see an increase in use over the coming years.

3.1.3 Changes in access conditions to Prince William Sound

In the past 10 years two notable changes have occurred that have impacted how recreationists can access the Sound. The first occurred in 2000 when the Whittier Tunnel opened to automobile traffic. Prior to this if one wanted to transport their boat, trailer and car to Whittier they were required to load them onto a railcar. The ability to drive through the tunnel has made it considerably easier to access Whittier by car. The Alaska Department of Transportation (ADOT) collects tolls for all vehicles that use the tunnel. In the first five years since automobile traffic was possible overall tunnel use has increased by 48% during the 5 month summer recreation season. However, since ADOT tracks use of the Whittier Tunnel based on various vehicle classes, we are able to estimate the number of vehicles that pass through the tunnel that are likely associated with recreation activities. Class B1 is defined as “Passenger vehicles pulling trailers, except as otherwise specified.” During the 5 month summer

recreation season, beginning in 2000 and ending in 2004, the number of vehicles in this class passing through the tunnel increased from 4,133* to 8,483. This is an increase of over 100%. It is unclear if use of the Whittier Tunnel will continue to increase; nonetheless, this change in the access to the Sound has had substantial impacts on use of the Sound and is one of the impetuses for the PWSHUS.

The second notable change occurred in 2006, one year after data for this study were collected, when the Alaska Marine Highway Department based one of its high speed ferries in Cordova. This marked the first time daily trips were scheduled to both Whittier and Valdez. Prior to this, ferry service to and from Cordova was limited to a few times a week on a conventional ferry. A high-speed ferry is capable of sailing the routes in half the time of a conventional ferry. The reduced travel times and daily service are expected to increase the number of people visiting Cordova.

3.2 Scoping/pilot study

Given the scale of the study site, Prince William Sound, a scoping/pilot study was conducted in 2004. This study was conducted by a research scientist with the USDA Forest Service in order to determine the scope of the study and provide guidance in the initial development of the survey instrument. The study consisted of dialogues with Chugach National Forest staff, members of the Small Boat Owners Association based in Anchorage, as well as residents and visitors of Alaska. Results of the study identified that there were three main access points to the Sound—Whittier, Cordova and Valdez. Furthermore, the primary recreation season on the Sound occurs between Memorial Day (early May) and Labor Day (late September). Extensive communication with resource managers of the Chugach National Forest identified specific issues they would like the study to focus on, including the dispersal of human use throughout the Sound, encounter levels of visitors, the identification of

* Prior to June 2002 ADOT did not track use of the in the B1 category. As a result we can only calculate vehicle numbers for June through September. Beginning with 2002 we were able to calculate vehicle numbers from May through September. This is not expected to have a substantial impact on the calculations and results presented in this section.

areas where human/wildlife interactions occur, and the ability to identify locations where visitors access land.

Three distinct recreation user groups were also identified during the scoping/pilot study—paddlers, cruisers and fishers/hunters. The paddling group used non-motorized boats, primarily sea kayaks, on the Sound. Both the cruisers and fishers/hunters used motorized boats and were distinguished by their vessels' ability to provide overnight accommodations. The cruiser group used boats with overnight accommodation and generally spent several days in the Sound per trip. They typically participated in fishing as a secondary activity. The final group, fishers/hunters, included users whose primary purpose was to participate in fishing and/or hunting, although fishing is the dominant activity of the two. Fishers/hunters' vessels generally did not include overnight accommodations. The trip length for this group varied dramatically. A majority of the trips were assumed to be short day trips, although some groups spent several days either fishing and/or hunting in the Sound.

3.3 Survey Design

There were two primary goals in designing the survey. First, the instrument should be consistent with the survey instrument designed for the National Visitor Use Monitoring project, a national data collection effort conducted by the USDA Forest Service for all national forests. Consistency with this broader survey instrument would enable us to collect comparable data. Second, the instrument should gather data that is relevant to the resource issues of the Sound. These two conditions resulted in a survey with two distinct parts discussed below. The initial survey design was completed in late 2004, with focus group testing of the instrument in Anchorage and Cordova in early 2005. The survey instrument was revised, with the final version completed in time to begin data collection on May 1st, 2005. Three versions of the survey were developed to target each user group. The bulk of the survey was the same across all three versions with the primary difference being wording modifications specific to each user group. Higher return rates can be expected if respondents are interested in the topic of the survey. (Salant and Dillman 1994).

3.3.1 Survey Components

The survey consisted of two main portions—text-based questions and a map diary/trip itinerary. The text-based portion of the survey gathered general use information, behavioral attributes, and demographic characteristics of the users. In the diary/trip itinerary portion respondents were asked to focus on a single trip, specifically their most recent, or current, trip in the Sound. The diary/trip itinerary portion included a 17" by 22" map of Prince William Sound on which users were asked to provide several pieces of information regarding their trip on the Sound. Users were asked to trace the travel route of their trip in the Sound. At each location they stopped, they were asked to number the site, provide the date & time of arrival, the length of stay, and a list of the activities in which they participated at each stop. Additionally they were asked to identify up to two of their stops as primary sites (P1 and P2), for which they were subsequently asked questions about in the text-based portion of the survey. A copy of the complete survey is provided as Appendix E.

3.3.2 Sample design

The sample design was randomized and stratified by port, day of week, and time of day. The three different sampling periods were morning (6:00-11:30), mid-day (11:30-17:00) and evening (17:00-22:30). These 5.5 hour periods were selected to coincide with the tunnel schedule for automotive access to Whittier. Further modifications of the sample design were necessary for the ports of Cordova and Valdez to coincide with the ferry schedule for transporting the survey crew covering these two ports. Sampling occurred between May 1st and September 30th of 2005. Data collection took place for 60 days in Whittier, 42 weekdays and 18 weekend days. A total of 42 days were sampled in Valdez, 31 weekdays and 11 weekend days. And in Cordova a total of 48 sampling days occurred, 34 weekdays and 14 weekend days. Combined this resulted in 150 days of sampling, 117 weekdays and 43 weekend days, over the summer recreation season at the three harbors.

Surveys were distributed through intercepts of the next available and willing recreation user. Brief interviews were conducted in order to identify each potential

respondent's user group, as well as allow them to ask questions about the study. Supplemental information about the respondents was collected during the interview (detailed below). During the interview, survey packets were distributed to willing participants. Survey packets consisted of the survey, a prepaid and pre-addressed return envelope, and a postcard for entry into a prize drawing. A cover letter was also included in the survey packet that outlined information about the study as well as provided necessary information regarding participants' rights in compliance with OSU's Institutional Review Board (IRB #2874). A reminder postcard was sent two-weeks after distribution of the surveys.

3.4 Data Collection

This section focuses on the specifics of how data were collected for this study. Details of the type of data collected as well as how they will be applied and analyzed will be discussed.

3.4.1 Survey Data

Two two-person crews distributed the surveys. One crew was based at the Glacier Ranger District office in Girdwood, Alaska and was responsible for collecting data on users accessing the Sound through Whittier. The second crew based at the Cordova Ranger district in Cordova, Alaska, was responsible for collecting data on users accessing the Sound through Cordova and Valdez. Travel between Cordova and Valdez was facilitated by the Alaska Marine Highway ferry system through a cost sharing agreement.

The survey crews were comprised of three undergraduate students hired as USDA Forest Service seasonal employees and one graduate student from Oregon State University who had volunteer status with the USDA Forest Service. Two of the seasonal employees were assigned to the Whittier crew under the supervision of the Glacier Ranger District staff. The other seasonal employee was assigned to the Cordova/Valdez crew with the graduate student, who also was responsible for supervising data collection. The majority of the data were collected by these crews except for the May 1-June 15 period and September 10-19 period. During these two

periods the undergraduate students were unavailable due to classes and other academic constraints. Staff from the Girdwood district collected data in Whittier from May 1st through June 15th before student employees arrived and from September 10th through September 30th after the student seasonal workers departed. Data were collected in both Cordova and Valdez by the graduate student from May 1st through June 15th and from September 10th through September 19th. From September 20th through September 30th, staff from the Cordova Ranger district collected data. From June 16th through September 9th the two person crew collected data in Cordova and Valdez.

3.4.2 On-Site Interviews

During intercepts on-site, each participant was asked to provide name and address to facilitate the mailing of follow-up reminder postcards. They were also asked to estimate the duration of their trip in either hours or days. The survey crew recorded their vessel type, whether they were beginning or ending their trip and what version of the survey they received (i.e., their user group).

3.4.3 Traffic Counts

Traffic counts were conducted during the sampling periods to provide estimates of the total number of recreation vessels entering and leaving the harbor. A web camera connected to a laptop computer was set up in line of sight of the harbor opening in order to record vessel traffic. Video was recorded onto the hard disk of the laptop computers. These video logs, corresponding to each sampling period, were cataloged and transferred to individual compact disks. Based on the video logs, spreadsheets were created that detailed the type of vessel and whether it entered or left the harbor. Vessel counts will be discussed in greater detail in Chapter 4. These data allow for estimates of sample rates as well as a means for calculating overall use at each of the harbors.

3.5 Summary

This chapter provided an overview of the study area as well as the details about the creation and implementation of the survey. Prince William Sound possesses many unique attributes, including abundant wilderness characteristics and relative low use.

However, use levels are increasing and are expected to increase in the near future. For these reasons, among others, a comprehensive study of the recreation use in the Sound is warranted.

Chapter 4 Sample and Return Rates, and Text-Based Data

This chapter provides an overview of data collected by the survey crews for the Prince William Sound Human Use Study. The following sections focus on the distribution, sample rates, return rates and summary statistics for the text-based data. Sample and response rates are segregated by harbor (Cordova, Valdez and Whittier) and by user group (fishers/hunters (F/H), cruisers (C), and paddlers (P)).

4.1 Sample Rates

Sample rates are calculated as the number of vessels sampled out of total vessels entering and/or leaving the harbor for recreation or subsistence purposes in the Sound. Total recreation vessel traffic counts during the sampling periods were derived from video monitoring equipment set up at the harbor entrances to record vessel traffic. Due to the video equipment not being available until mid-May we are unable to calculate sample rates for early May. The lack of calculated sampling rates for early May is likely not an issue and has little effect on the overall study.

Survey avoidance bias may be present in this study. Survey crews encountered respondents who, because they had already been handed a survey on a previous trip, refused to accept a survey for their current trip. Survey avoidance bias was witnessed on two different levels. The first form of bias noted by the crew in Valdez occurred when visitors, especially those participating in fishing activities, would do so on several consecutive days, often refusing surveys the second and subsequent times they were approached. These consecutive fishing trips were verbally reported to survey crews as being consistent, i.e. primarily to the same location and for the same duration as respondents original trip for which they accepted a survey. This form of self-selection may bias the data by not revealing the number of consecutive, and similar, trips that occurred from Valdez. However since we are interested in sampling trips, not users, we should derive more than one observation per user for those that frequently use the Sound. The second form of self-selection bias occurred on a larger timescale. A small amount of users refused a second or subsequent survey because they had received one during the early portion of the season. This was particularly

evident in Cordova where the population of users appears to be small enough that the survey crew became familiar with local, repeat, users. However, given low use rates in the early part of the season, avoidance bias due to early season effects should be relatively small. Unfortunately, we do not have any means of measuring the degree of bias or evaluating its statistical significance.

Overall Sample Rates

Table 2 provides the sample rates for the Sound by month and by user group. A total of 2085 surveys were distributed across the three harbors. From June to September a total of 6248 vessels were counted, which resulted in an overall sample rate of 27%. The fishing and hunting version of the survey was distributed 71% of the time, the cruising version 21% of the time, and 5% of the surveys distributed were to paddlers. Approximately 3%, or 54 surveys, distributed by the Whittier survey crew were not recorded or identified by user type. While this will limit our ability to calculate specific sample rates per survey version, we are still capable of calculating overall sample rates.

Table 2: Overall sample rates for Prince William Sound.

Overall	May	June	July	August	September	Total
Fishers/Hunters	246	240	385	474	142	1487
Cruisers	92	87	154	76	22	431
Paddlers	23	38	29	20	3	113
Unknown	30	12	11	1	0	54
Total Surveys	391	377	579	571	167	2085
Total Vessels	----	1401	1926	2205	716	6248
Sample Rate	*	27%	30%	26%	23%	27%[t]

* Sample rates are not available for May due to the lack of total vessels count.

[t]Overall sample rate is based on total surveys/total vessels for June through September only.

Cordova Sample Rates

Table 3 provides sample rates for Cordova. The logistics of intercept sampling in Cordova were complicated by several factors. The main harbor actually contains two separate docks with different access gangways on opposite sides of the boat basin separated by several hundred feet. The harbor has a single boat entrance to the Sound so the web camera could capture vessel traffic for both docks. A third access point to the Sound where users could be intercepted is a remote boat ramp located at the north end of Cordova, generally referred to locally as the North Containment. Sampling protocol called for one member of the crew to focus on the main harbor while the other member stayed at the North Containment area. The two access points for the harbor are about a ten minute walk apart. The crew primarily focused their efforts on the larger of the two harbors, while still trying to intercept possible respondents at the smaller one. Traffic at the North Containment was small enough that everyone was intercepted during the sampling period.

As expected, the traffic in Cordova was limited. A total of 128 surveys were distributed with an estimated overall sample rate for the season at 22%, which is the lowest among the three harbors. Intermittent video monitoring malfunctions reduced the number of sampling periods with corresponding traffic counts. Specifically in Cordova we experienced problems with the equipment resulting in no traffic counts on three of the sampling days. The estimated sample rate is therefore based on surveys distributed during sample periods when the traffic counts were also being gathered. About 70% of the surveys were distributed to fishers/hunters, 25% to cruisers, and 5% to paddlers. The number of surveys distributed varied by month with peak distribution occurring in July with 42 surveys and a low in September with 2 surveys. There is a noticeable drop in the number of surveys distributed during June, which could be attributed to avoidance bias given the small population of users during the early part of the sampling period.

Sampling rates varied between weekdays and weekend days. Based off the days where traffic counts were obtained the weekday sampling rate in Cordova

equaled 20% while the weekend days equaled 40%. Sampling rates were thus doubled on weekend days as compared to weekdays. This could perhaps be attributed to both an increase in recreational tourist on the weekend as well as local residents' ability to recreate because they do not work on the weekends.

Table 3: Sample rates for Cordova

Cordova	May	June	July	August	Sep.	Total
F/H	24	14	24	26	1	89
C	5	6	18	3	0	32
P	2	3	0	1	1	7
Surveys @ Harbor	31	19	37	26	2	115
North Containment Surveys	0	4	5	4	0	13
Total Surveys	31	23	42	30	2	128
Surveys w/ Camera	9	19	37	26	2	93
Total Vessels	35	83	167	114	17	416
Sample Rate[a]	26%	23%	22%	23%	12%	22%

[a]Due to intermittent video monitoring failures, sampling rates are based on periods when traffic monitoring counts were available.

Valdez Sample Rates

Table 4 provides sample rates for Valdez. Traffic at Valdez was significantly higher than Cordova—656 surveys were distributed over the study period. The sample rates in Valdez were similar to those from Cordova. Other than the month of May, estimated sampling rates remained between 20-27%, with an overall sample rate for the season of 24%. The number of surveys distributed varied considerably by month with peak distribution occurring in August with 216 surveys and a low in September with 85 surveys. Over 85% of the surveys distributed were to fishers/hunters, the highest proportion out of all of the harbors. Just over 12% of the surveys were distributed to cruisers, while only 3% were given to paddlers. This larger degree of variation between survey types is not surprising, given that Valdez is considered a destination for anglers. Intermittent video monitoring malfunctions reduced the number of sampling periods with corresponding traffic counts.

Specifically in Valdez equipment failure resulted in 4 days without traffic counts and 2 days with partial traffic counts where only a portion of the sampling period's traffic count was recorded. These malfunctions are not expected to impact the results of this study.

Sample rates varied slightly between weekdays and weekend day in Valdez. Weekend sampling rates equaled 22 while weekday sampling rates equaled 25%. This consistency is not to surprising since Valdez is known to be a destination for tourists. As a result the influence of local residents working schedule is minimal.

Table 4: Sample rates for Valdez

Valdez	May	June	July	August	Sep.	Total
F/H	65	85	116	211	81	558
C	27	20	22	5	3	77
P	5	14	1	0	1	21
Total Surveys	97	119	139	216	85	656
Surveys w/ Camera	46	132	126	200	85	589
Total Vessels	73	525	580	1008	318	2504
Sample Rate[a]	63%	25%	22%	20%	27%	24%

[a]Due to intermittent video monitoring failures, sampling rates are based on periods when traffic monitoring counts were available.

Whittier Sample Rates

Table 5 provides sample rates for Whittier. Whittier had the largest number of surveys distributed across the three harbors; however, more sampling days were spent at Whittier than the others. Even adjusting based on 20 additional sampling days, Whittier still had the highest use rates. A total of 1301 surveys were distributed in Whittier. The overall sample rate at Whittier was 34%. Nearly 65% of the surveys were distributed to fishers/hunters, 25% to cruisers, and 7% to paddlers, similar to the distribution of users at Cordova. The highest sampling periods based on number of surveys distributed was July/August, consistent with the other harbors.

Sampling rates varied slightly between weekdays and weekend days in Whittier. Weekend days equaled 32% while weekdays totaled 36%. This could be attributed to the work schedules of local residence, including those from Anchorage,

Alaska's largest population center. Intermittent video monitoring malfunctions reduced the number of sampling periods with corresponding traffic counts. Specifically in Whittier we experienced problems with the equipment resulting in no traffic counts on eight of the sampling days. Additionally, there were 19 days where equipment failure resulted in partial traffic counts for the sampling period. These malfunctions are not believed to have a significant impact on the results of this study.

Table 5: Sample rates for Whittier

Whittier	May	June	July	August	Sep.	Totals
F/H	157	141	245	237	60	840
C	60	61	114	68	19	322
P	16	21	28	19	1	85
Unknown[a]	30	12	11	1	0	54
Total Surveys	263	235	398	325	80	1301
Total Vessels	393	793	1179	1083	381	3829
Sample Rate	67%	30%	34%	30%	21%	34%

[a]Due to intermittent video monitoring failures, sampling rates are based on periods when traffic monitoring counts were available.

4.2 Return rates:

Return rates are based on the number of surveys returned out of the known number of surveys distributed. As discussed in the previous section, survey crews kept track of the number of surveys distributed of each version of the survey. This allows us to calculate return rates for each of the three versions of the survey as well as by harbor. In a small number of cases, technical problems resulted in the inability to determine the type of survey that was distributed by the survey crew in Whittier. However, given the small number of unknown user types, approximately 3% or 54 surveys, the effects are small on overall return rates. No indicators were added to the survey to distinguish at which harbor they were distributed; this information was inferred by examining respondents' travel itineraries. In most cases, itineraries indicated the same starting and ending location, which was then used to identify the harbor at which the survey was distributed. For those surveys where different harbors were indicated, the assumption was made that they received the survey at the beginning of their trip. The date of the trip was inferred in the same manner; i.e., the date indicated for the beginning of the trip was used. This method of calculating return rates did lead to some unreasonable outcomes. A result of 200% of the paddling surveys being returned from Whittier for the month of September is most likely due to respondents receiving the survey during the month of August and providing an itinerary for a trip in September. Similar discrepancies could have

occurred when 100% of the surveys were returned. This is a small sample effect with only three surveys being distributed to paddlers in the month of September.

Overall Return Rates:

The number of surveys returned varied by location and by survey type. The tables below illustrate these differences. While higher return rates are desirable, the return rates are very good considering the degree of difficulty with the survey, namely the trip itinerary. Other, likely minor, factors associated with low response rates include anecdotal evidence from comments received during survey distribution, such as hesitation to reveal favorite hunting and fishing locations (directly contributing to lower response rates for fishers/hunters) and the quality of the map included in the survey (some participants requested an extra copy just for the map). Whittier had the highest return rates at 35% overall to a low of 20% for Cordova (Valdez's overall return rate was 25%). A likely explanation for the higher return rate in Whittier is a much larger population of urban users from the Anchorage area and reduced incidence of users being repeatedly sampled.

Table 6 provides the overall return rates for the Sound. The overall return rate for the survey was 31%. Paddlers had the highest return rate at 49% overall. Cruisers return rate was 39%, while fishers/hunter's return rate was 28%. June had the highest overall return rate, 37%, with July following closely at 35%. September, at the end of the sample period, had the lowest overall return rate at 20%.

Table 6: Overall return rates for Prince William Sound.

	May	June	July	August	September	Return Rate
F/H	24%	32%	34%	28%	15%	28%
Cruising	33%	53%	36%	39%	41%	39%
Paddling	48%	45%	62%	30%	100%	49%
Total	25%	37%	35%	29%	20%	31%

Cordova Return Rates

Table 7 provides return rates for Cordova. The overall return rate for Cordova was 20%, the lowest of all three harbors. Cruisers returned the highest proportion of

surveys at 34%. Fishers/hunters returned 17% of their surveys, while only one of the seven paddlers returned a survey, resulting in a 14% return rate. Return rates were fairly constant at around 22% for Cordova during the months of May, June and July. August had a slightly lower return rate at 17%. Only one survey was returned of those distributed during September.

Table 7: Return rates for Cordova.

	May	June	July	August	September	Return Rates
F/H	25%	14%	17%	12%	0%	17%
Cruising	20%	50%	28%	67%	NA	34%
Paddling	0%	0%	NA	0%	100%	14%
Total	23%	22%	21%	17%	50%	21%

Valdez Return Rates

Table 8 provides return rates for Valdez. Overall, 25% of the surveys distributed in Valdez were returned. Both the cruisers and paddlers had return rates at 38%, while 23% of the fishers/hunters returned their surveys. Looking at the monthly return rates we see that four out of the five months ranged from 23-34%, while September had the lowest monthly return rate at 11%.

Table 8: Return rates for Valdez.

	May	June	July	August	September	Return Rates
F/H	23%	28%	27%	23%	10%	23%
Cruising	33%	20%	68%	20%	0%	38%
Paddling	40%	29%	100%	NA	100%	38%
Total	27%	27%	34%	23%	11%	25%

Whittier Return Rates

Table 9 provides return rates for Whittier. The overall return rate for Whittier was 35%, the highest of all three harbors. The paddling version was returned most frequently at 55%, but it was also the least distributed. Cruisers returned their surveys 40% of the time, while fishers/hunters returned their surveys 33% of the time.

Looking at the monthly return rates we see that they ranged from 25% in May to 43% in June. As mentioned above, the lower response rate for May could be attributed to respondents receiving the survey in May and providing information about a trip in June. September return rates for Whittier are quite different from the pattern observed for the eastern Sound (Cordova and Valdez). Whittier's September return rate was 30%.

Table 9: Return rates for Whittier.

	May	June	July	August	September	Return Rates
F/H	24%	35%	39%	34%	22%	33%
Cruising	33%	64%	31%	40%	47%	40%
Paddling	56%	62%	61%	32%	200%	55%
Total	25%	43%	37%	35%	30%	35%

4.3 Number of reported trips and surveys distributed:

The previous section presented the number of surveys distributed as well as the return rates. A brief discussion about the relationship between returned surveys and number of trips entered into the database is warranted. The text based portion of the survey was used from every survey that was returned, although some questions may not have been answered by respondents. Some returned surveys did not have a completed map/itinerary section, while others had multiple trips displayed. Those surveys without the map/itinerary portion decreased the number of trips we were able to base our sample on. However, for surveys with multiple trips, each of the subsequent trips was also digitized and entered into the database. Given that we are interested in evaluating trips in the Sound and due to the relatively small overall sample sizes, we decided that these secondary trips should be included in the analysis. The earliest trip was assumed to be the primary trip by the respondents; subsequent trips were given unique identifiers in the database in order to distinguish them. Calculations indicate that less than 10% of the surveys included multiple trips. Trips based on the map/itinerary section comprise the data used for the analysis in Chapter

5. The use of secondary trips should have little effect on the analysis performed for this thesis.

4.4 Survey logs:

Survey logs recorded information on potential respondents during the short willingness-to-participate, on-site interviews at the harbors. In particular, respondents were asked to provide an estimate of the duration of their trip. Trip durations were categorized into three different groups—≤ 1 day; 2-6 days; or 7+ days. Table 10 shows the distribution of respondents by length of stay by harbor. Whittier had proportionally fewer ≤ 1 day users than Cordova or Valdez, although this type of user was the dominant type for all harbors evaluated. Whittier had proportionally more 2-6 day trips than the other harbors. Trips lasting 7 days or longer were the least common trip type in the Sound.

Table 10: Length of estimated stay in Prince William Sound by harbor

	≤ 1 Day	2-6 Days	7+ Days
Cordova (N=152)	82	13	5
Valdez (N=813)	84	15	2
Whittier (N=985)	58	40	3
Total	70	27	3

All entries are percentages (%)

4.5 Vessels Used:

Survey respondents were asked about type of vessel for primary and secondary use during their visit to the Sound (Question A9). The survey included a list of 10 commonly used vessel types as well an open-ended "other" category. Table 11 shows the frequency of each primary vessel type, including "other" entries.

Table 11: Number and type of vessels used

Cabin Cruiser*	304
Runabout*	157
Skiff*	92
Sea Kayak*	50
Water Taxi*	45
Motor Yacht*	29
Sail Boat*	24
Inflatable*	17
Commercial*	6
Bow Picker	4
Jet Ski*	3
Dory	2
Jet Boat	2
River Boat	2

* Indicate choices on the survey.

To simplify analysis, the list of vessel types can be consolidated based on similar characteristics such as possessing overnight accommodations (e.g., motor yachts can be grouped in the category of Cabin Cruisers). Table 12 shows the grouping of vessels that will be used when associating them with activities participated in the Sound. A description, as defined for the purposes of this study, of each vessel type is included below.

Table 12: Consolidated list of vessels used.

Cabin Cruiser	333
Runabout	166
Skiff	109
Other	56
Sea Kayak	50
Sailboat	24

4.6 Activities associated with vessel type:

The Chugach National Forest has expressed interest in determining the location and type of activities visitors to the Sound participate in during their trips. Comprehensive visitor monitoring of the Sound would be prohibitively expensive and time-consuming on an ongoing basis. In contrast, monitoring traffic flows can be accomplished with a variety of methods and at much lower cost than visitor intercept

surveys. Since vessel type is readily visible (although classification is to some degree ambiguous) and can be monitored at relatively low cost, associating visitor use patterns with vessel type has the potential to provide a method for estimating visitation levels and activity participation. This method is based on responses to the map itinerary portion of the survey. The results presented here are intended to assist the managers of the Chugach National Forest in the creation of a monitoring plan for the recreation use in the Sound. Furthermore this study is expected to provide predictive means of assessing what activities users may be participating in during their trips into the Sound.

In order to address the relationship between vessel types and their associated activity types, two different analyses were conducted. The first analysis anchors on vessel type and determines the associated percentage of participation for each activity category. The second method of analysis anchors on activity types and illustrates the associated percentage of vessels that participated in an activity. For convenience, activities were grouped by whether they were water or land based. Total participation can sum to greater than 100% since participants selected all activities that apply.

4.6.1 Activity participation by Vessel Type:

We begin with the first analysis that anchors on vessel type and identifies the associated activities listed by respondents. For each vessel type, the percentage of respondents reporting participation in each activity is displayed on the Figures 1 through 6. Comparisons across vessel types should be done with caution. The number of respondents varies greatly for each vessel type; i.e., from 24 respondents to 333 respondents.

Runabouts: A runabout consists of a vessel large enough to accommodate a small group of people (up to approximately 6) with a primary purpose of transport. The engines for runabouts are generally powerful enough to allow users to cruise at speeds above 20 knots. Both inboard and outboard engines were observed by survey crews. Runabouts are distinguishable from Cabin Cruisers in that they do not provide

sleeping accommodations, and from skiffs by their size and providing a cockpit area for navigating the vessel.

Figure 2 illustrates the percent of participation in each of the 20 categories for users of runabouts. Fishing is the dominant activity (27% combined including shrimping) for this group. Sightseeing (11%) and anchoring (10%) are also significant activities for visitors with runabouts. A runabout vessel is designed to allow users to quickly travel between locations, which would allow users to visit many different locations for sightseeing purposes. The fact that camping on boat was a significant activity participated in (10%) is somewhat surprising since by our definition these vessels do not have sleeping accommodations onboard. This could be a result of users having different criteria for identifying their vessel type. Runabouts did not report participation in deer hunting (0%) or kayaking local area (0%). Kayaking the local area would require transportation of kayaks and many runabouts are limited in size and therefore not efficient at transporting kayaks. Also, kayaking may be considered a means of sightseeing and since sightseeing was listed as the top activity by runabout users they may be using their runabout instead of kayaks to explore local areas.

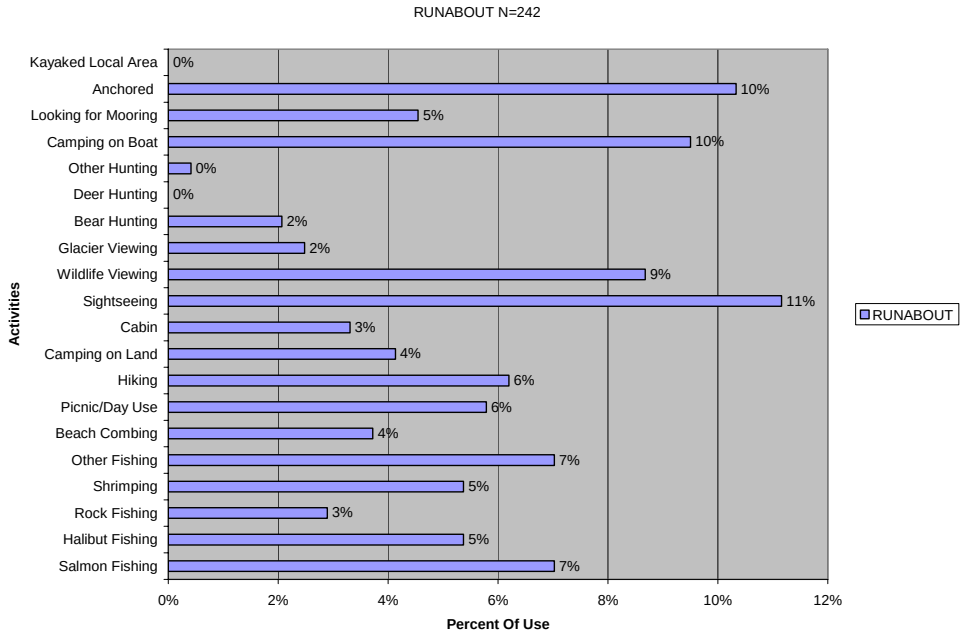


Figure 2: Activities associated with Runabouts.

Cabin Cruisers: Cabin cruisers consist of vessels large enough to carry multiple people within the structure of the vessel and are equipped with a head, galley, and at least one sleeping berth. The onboard accommodations of cabin cruisers allow for multiple day trips, and distinguish them from the runabouts. Cabin cruisers are distinguished from larger sailboats by the exclusive reliance on motorized propulsion.

Figure 3 illustrates the percent of participation in each of the 20 categories for users of cabin cruisers. We can see that participation rates in anchoring (15%) and camping on their boat (14%) are nearly the same. This is likely due to the fact that in order to camp on the boat, secure anchoring is required. Hunting (3% combined) does not appear to be a primary activity for this group; however, fishing (21 % combined, including shrimping) was reported most frequently. Activities such as sightseeing (11%), wildlife viewing (10%) and hiking (8%) were reported often.

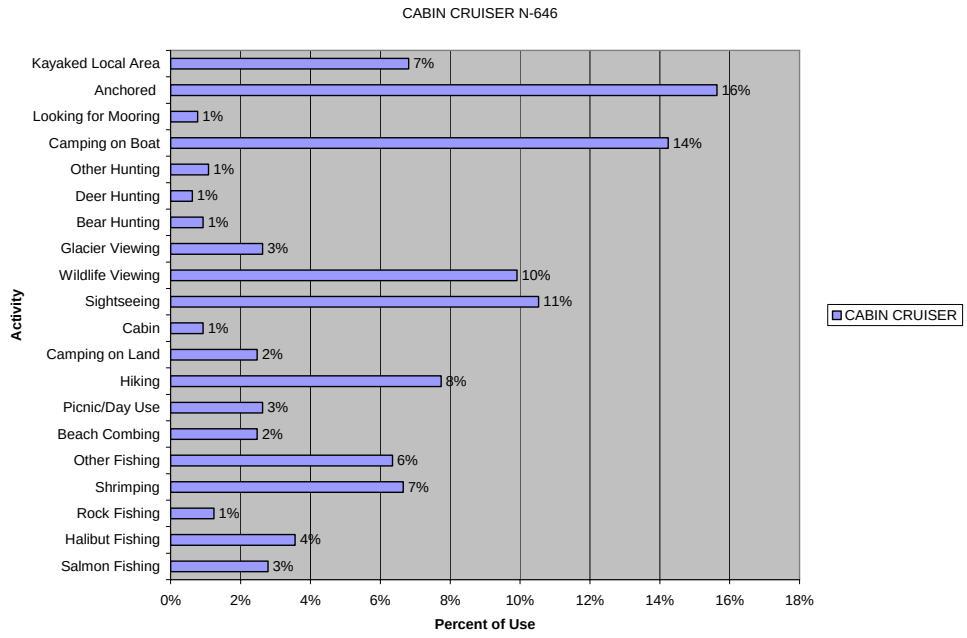


Figure 3: Activities associated with Cabin Cruisers

Skiff: Skiffs consist of smaller vessels with limited space for people and gear. Their engines are generally small outboard engines and have direct steering controls

on them; i.e., no separate steering wheel. Cruising speeds for skiffs are lower than both runabouts and cabin cruisers, averaging between approximately 10-15 knots.

Figure 4 illustrates the percent of participation in each of the 20 categories for users of skiffs. Sightseeing (11%), wildlife viewing (9%) and hiking (9%) were reported frequently. It is unclear from these data if the sightseeing and wildlife viewing occurred while on water or in combination with hiking. Hiking on established trails is associated with impacts such as loss of vegetation, shifts in species composition and soil compaction (Cole, 1990). This group camped on land (7%) or stayed in a cabin (6%) relatively frequently. Both of these would indicate longer durations on land and the opportunity for different impacts. Combined fishing percentages were highest at 29%. Hunting (4% combined) was done by a limited number of participants.

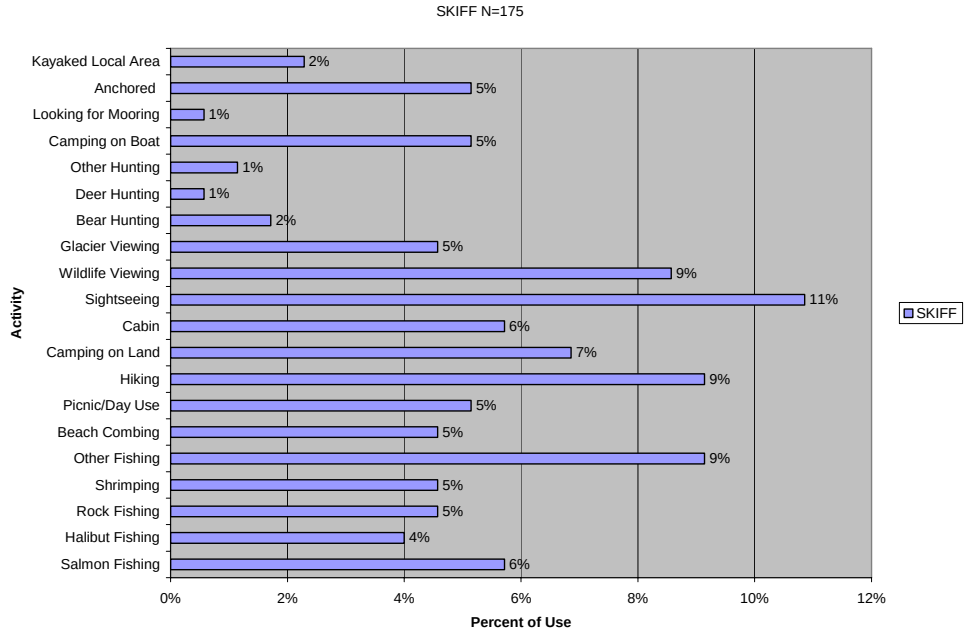


Figure 4: Activities associate with Skiff

Sea Kayak: Sea kayaks are small one or two person vessels propelled by paddling. Due to their small size they have a limited capacity for storage, although

properly planned and packed they can accommodate essential supplies for multiple day trips. Since sea kayaks are hand-powered, their speed and distance of travel are limited.

Figure 5 illustrates the percentage of participation in each of the 20 categories for users of sea kayaks. Sea kayakers only reported participation in 11 out of the 20 possible activities; the fewest of any of the vessel types. As with users of skiffs, the use was primarily focused on non-consumptive activities such as sightseeing (22%), wildlife viewing (20%) and hiking (14%). All multi-day sea kayaking trips included either onshore camping (17%) or a stay in a cabin (3%), both of which are land-based activities. Twardock and Montz (2000) found that over a 12-year period (1987 to 1998), the use of the Sound by sea kayakers increased 7.5% per year. Their study was conducted prior to the opening of the Whittier tunnel to automobile traffic which they concluded would likely increase use even more. Sea kayakers participate in land-based activities approximately 42% of the time. If sea kayaking continues to grow at predicted rates, it is reasonable to assume that there will be more use of onshore areas by this user group.

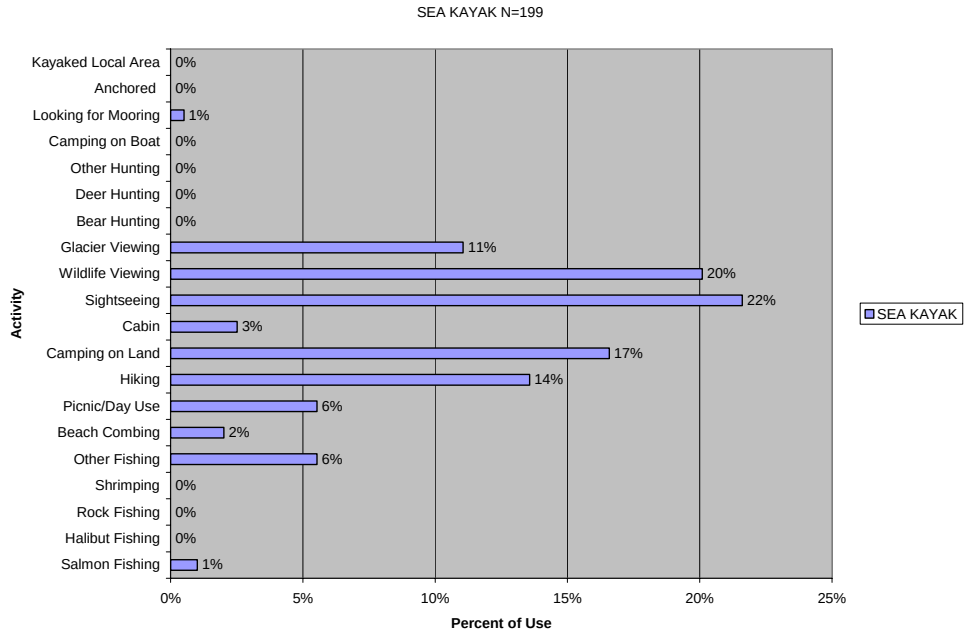


Figure 5: Activities associated with Sea Kayaks

Sail Boat: Sail boats are able to accommodate a limited number of people, generally less than five. As the name suggests they are primarily powered by the use of a sail, however, virtually all sail boats used in the Sound are equipped with small auxiliary motors for use when wind speed is limited or docking their vessel. Sleeping accommodations and kitchenettes are common, which allow for multiple day trips. Cruising speeds are relatively low, often below 10 knots.

Figure 6 illustrates the percentage of participation in each of the 20 categories for users of sail boats. Users of sail boats appeared to focus on activities such as kayaking local area (14%), anchoring (15%), wildlife viewing (13%), sightseeing (14%), beach combing (6%) and hiking (11%). These non-consumptive activities account for approximately 73% of the activities for this group. Fishing participation was relatively limited - 9% participated in Halibut fishing, 2% in salmon fishing and 4% in shrimping. There were no reports of either rock or "other" fishing. This group also reported no participation in any of the hunting categories. Based on the map/itinerary portion of our sample, sail boat users camping on-board their vessel was virtually non-existent (1%). However, in the text-based portion of the survey 89% of sailboat users reported participation in the mooring of their sailboat overnight. It would be plausible to assume that mooring overnight coincided with users camping onboard their sailboat.

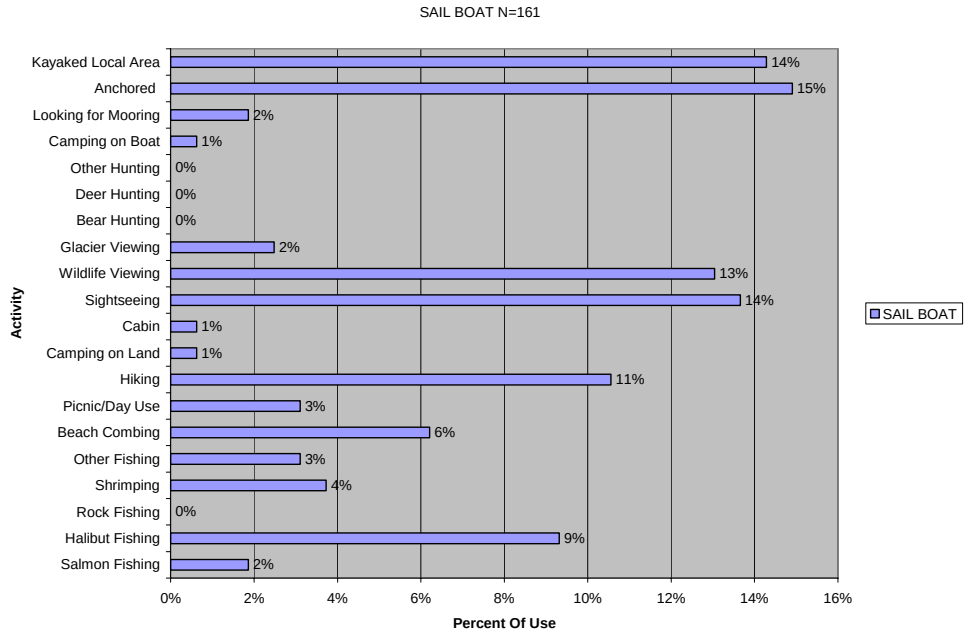


Figure 6: Activities associated with Sail Boats

Other Vessels: Other vessels consist of the list of vessels that did not fit into one of the previously defined five vessel categories. Examples include jet skis, river boats and inflatables. These vessel types vary in their ability to transport users and gear. For example very little could be transported on jet ski; however, a riverboat may be able to transport several people and gear. Cruising speeds for these vessels varies dramatically.

4.6.2 Rates of participation for different vessel types

In this section we used chi-squared analysis to test for differences in the participation rates for each vessel type. In order to perform this analysis we needed to aggregate on common activity types, for example all hunting activities were grouped together. This analysis also omitted the vessel category 'other' due to limited participation in activities and heterogeneity of vessel types in this group.

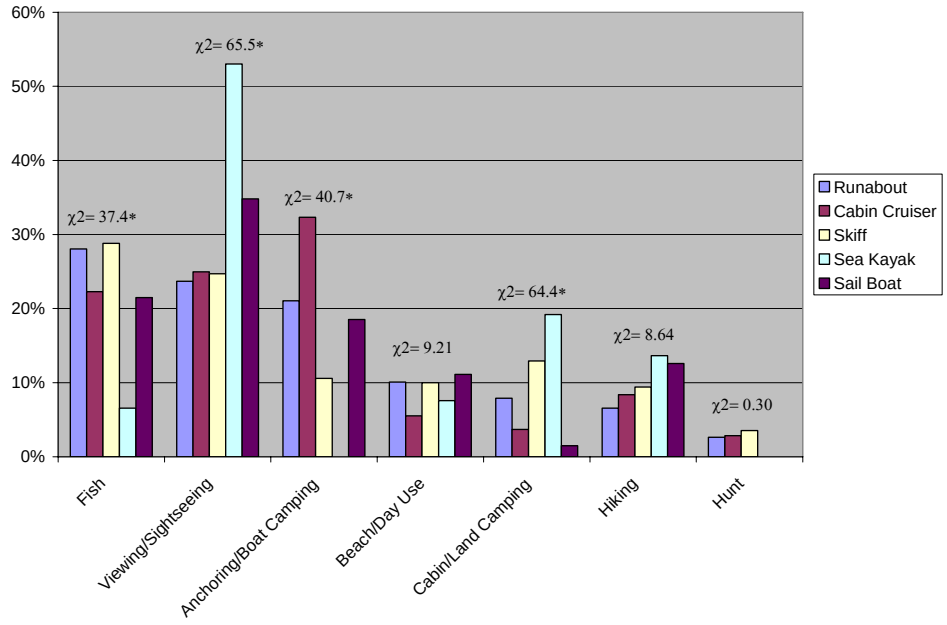
Our null hypothesis is that the rates of participation are identical across all vessel types (H_0: $\mu_{Runabout}=\mu_{Cabin\ Cruiser}=\mu_{Skiff}=\mu_{Sea\ Kayak}=\mu_{Sail\ Boat}$). In order to test this, a chi-squared test was run for each activity group on all five vessel types. If a

significant difference was found, we ran subsequent tests after removing the vessel type which, according to the graph, appeared to be the one most likely to be significantly different. This was repeated until we failed to reject the null hypothesis indicating that the remaining proportions of participation are not significantly different.

The chi-squared test is a member of the nonparametric family of statistical tests. Chi-squared is employed to test the difference between an actual sample its assumed distribution. It can also be used to test the difference between two or more actual samples. The basic computation for chi-squared is equal to the summation of the observed frequencies (n_{ij}) minus the expected frequencies ($n_i n_j / n..$), squared, and all divided by the expected frequencies.

$$\chi^2 = \sum^{r}_{i=1} \sum^{c}_{j=1} (n_{ij} - n_i n_j / n..)^2 \; / \; n_i n_j / n..$$

In our case, the observed cell count in row *i,* is the frequency of participation, in an activity, of a particular vessel type. The columns, *j*, are the different vessel types. Thus, we are testing whether frequencies of participation is homogeneous across vessel types, or not.



* Indicates significance at the 0.05 level

Figure 7: Rates of participation and chi-squared results for different vessel types

Fishing: All five vessel groups participated in fishing. The chi-squared statistic (34.7, p-value <0.00) indicates that there is a significant difference in participation rates among vessel types. Visual analysis of Figure 7 illustrates that users of sea kayaks likely are the group influencing the results of the chi-squared analysis. We used chi-squared a second time in order to test the null hypothesis that the remaining four vessel types have equal participation rates in fishing activities. (H_0: $\mu_{Runabout}=\mu_{Cabin\ Cruiser}=\mu_{Skiff}=\mu_{Sail\ Boat}$) The chi-squared statistic (5.56, p-value=0.135) indicates that we fail to reject the hypothesis that there is not a significant difference in participation rates for these four vessel types. Therefore we can conclude that the participation rates for the sea kayaking user group are statistically different than the remaining four vessel types.

Viewing and sightseeing: All five vessel groups participated in these activities. The chi-squared statistic (65.5, p-value <0.00) indicates that there is a significant difference in participation rates among vessel types. Visual analysis of Figure 7

illustrates that users of sea kayaks likely are the group influencing the results of the chi-squared analysis. We used chi-squared a second time in order to test the null hypothesis that the remaining four vessel types had equal participation rates in viewing and sightseeing activities. (H_0: $\mu_{Runabout}=\mu_{Cabin\ Cruiser}=\mu_{Skiff}=\mu_{Sail\ Boat}$) The chi-squared statistic (6.58, p-value=0.086) indicates that we fail to reject the hypothesis that there is not a significant difference in participation rates for these four vessel types. Therefore we can conclude that the participation rates for the sea kayaking user group are statistically different than the remaining four vessel types.

Anchoring and boat camping: Users of sea kayaks did not report any participation in this activity group and were consequently omitted from the chi-squared tests. The null hypothesis was that the remaining four vessel types had equal participation rates in anchoring and boat camping activities (H_0== $\mu_{Runabout}=\mu_{Cabin\ Cruiser}=\mu_{Skiff}=\mu_{Sail\ Boat}$). The chi-squared statistic (40.7, p-value<0.00) indicates that there is a significant difference in participation rates among these four vessel types. Visual analysis of Figure 7 illustrates that users of skiffs likely are the group influencing the results of the chi-squared analysis. We used chi-squared a second time in order to test the hypothesis that the remaining three vessel types had equal participation rates in anchoring and boat camping activities. (H_0== $\mu_{Runabout}=\mu_{Cabin\ Cruiser}=\mu_{Sail\ Boat}$) The chi-squared statistic (17.1, p-value<0.00) indicated that there is a significant difference in participation rates among these three vessel types. Next we replaced the skiffs and dropped the cabin cruisers (H_0== $\mu_{Runabout}=\mu_{Skiff}=\mu_{Sail\ Boat}$) and ran a third chi-squared test to test the hypothesis that the remaining three vessel types had equal participation rates in viewing and sightseeing activities. The chi-squared statistic (7.80, p-value=0.02) indicated that there was a significant difference in participation rates among these three vessel types. We used chi-squared a fourth time, dropping both cabin cruisers and skiffs, to determine if there was a significant difference in the participation rates for sail boats and runabouts. The chi-squared statistic (0.339, p-value-0.56) indicates that we fail to reject the hypothesis that there is not a significant difference in participation rates between sail boats and runabouts.

Statistics show that participation rates for all vessel types are different with the exception that sail boats and runabouts are equal.

Beach and day use: All five vessel groups participated in these activities. The chi-squared statistic (9.21, p-value <0.056) indicates that we fail to reject the null hypothesis that there is not a significant difference in the participation rates among these vessel types.

Cabin and camping on land: All five vessel groups participated in these activities. The chi-squared statistic (64.4, p-value <0.00) indicates that there is a significant difference in participation rates among all vessel types. We used chi-squared a second time in order to test the null hypothesis that the top three vessel types had equal participation rates in cabin and camping on land activities. (H_0: $=\mu_{Skiff}$ $\mu_{Runabout}$ $=\mu_{Sea\ Kayak}$). The chi-squared statistic (11.9, p-value <0.03) indicates that there is a significant difference in participation rates among these three vessel types. We used chi-squared a third time in order to test the null hypothesis that the bottom three vessel types had equal participation rates in cabin and camping on land activities. (H_0: $\mu_{Runabout}=\mu_{Cabin\ Cruiser}=\mu_{Sail\ Boat}$) The chi-squared statistic (10.1, p-value<0.006) indicates that there is a significant difference in participation rates among these three vessel types. Next we tested all possible pairs of vessel types. We found that sea kayaks had different participation rates that runabouts, cabin cruisers and sailboats. We found that skiffs had different participation rates than cabin cruisers sail boats. We found that runabouts had different participation rates than skiffs, cabin cruisers and sail boats. We found that cabin cruisers had different participation rates than sea kayaks, skiffs and runabouts. Finally, we found that sail boats had different participation rates than sea kayaks, skiffs and runabouts.

Hiking: All five vessel groups participated in these activities. The chi-squared statistic (8.64, p-value <0.071) indicates that we fail to reject the null hypothesis that there is not a significant difference in the participation rates among these vessel types.

Hunting: Users of three vessel types reported participation in hunting activities; runabouts, cabin cruisers and skiffs. The chi-squared statistic (0.301, p-

value <0.86) indicates that we fail to reject the null hypothesis that there is not a significant difference in the participation rates among these vessel types.

Using chi-squared we determined that there were no statistical differences in the participation rates among vessel types which participated in beach/day use, hiking and hunting activities. The sea kayak vessel type has statistically higher participation rates in viewing and sightseeing activities. Additionally the sea kayak vessel type has statistically lower participation rates in fishing activities. Participation rates for anchoring and boat camping activities varied by vessel type. For example cabin cruisers had higher participation rates while skiffs had lower participation rates. Finally, we found that participation rates for cabin and land camping activities was heterogeneous.

4.6.3 Vessel-type distribution by activity

The second way we examined how participation in activities relates to the vessels used was by looking at the specific activity types and illustrating the proportion of each vessel type associated with participation in an activity. For this portion of the analysis, the activities were grouped into either land- or water-based activities as defined earlier. The percentage of participation, in each of the different activities categories, for each vessel type was then calculated and graphed. This should allow managers to ask the question: "For a specific activity of interest, what vessel types would be likely to have users who participated in that activity?" Similar to what was mentioned earlier, it is important to remember that not all the vessel types were used equally. Therefore, vessels used more frequently would be expected to contribute more to visitation associated with the various activities.

Figure 8 shows proportion of use for water-based activities based on vessel type. Users with cabin cruisers participated in all of the different water based activities, dominating use in many of them. They accounted for over 70% of the reported occurrences of camping on their boat. Likewise they accounted for over 60% of the reported anchoring done in the Sound. Users of runabouts were also well-

represented in all the different water-based categories and reported the highest percentage of use in the looking-for-mooring category. The sea kayaking population reported low participation in many of the categories; however they reported high use in the various viewing categories (Sightseeing, Wildlife and Glacier Viewing). Users of skiffs also participated in most of the different water-based activities with the exception of camping on their boat. They reported an equal amount of participation as the cabin cruisers in the rock fishing category. Halibut fishing was the highest reported use by users with sailboats while they represented very little of the reported camping on boat. Finally, the vessels grouped in the category of "other" represented very little of the overall participation in all of the different activities.

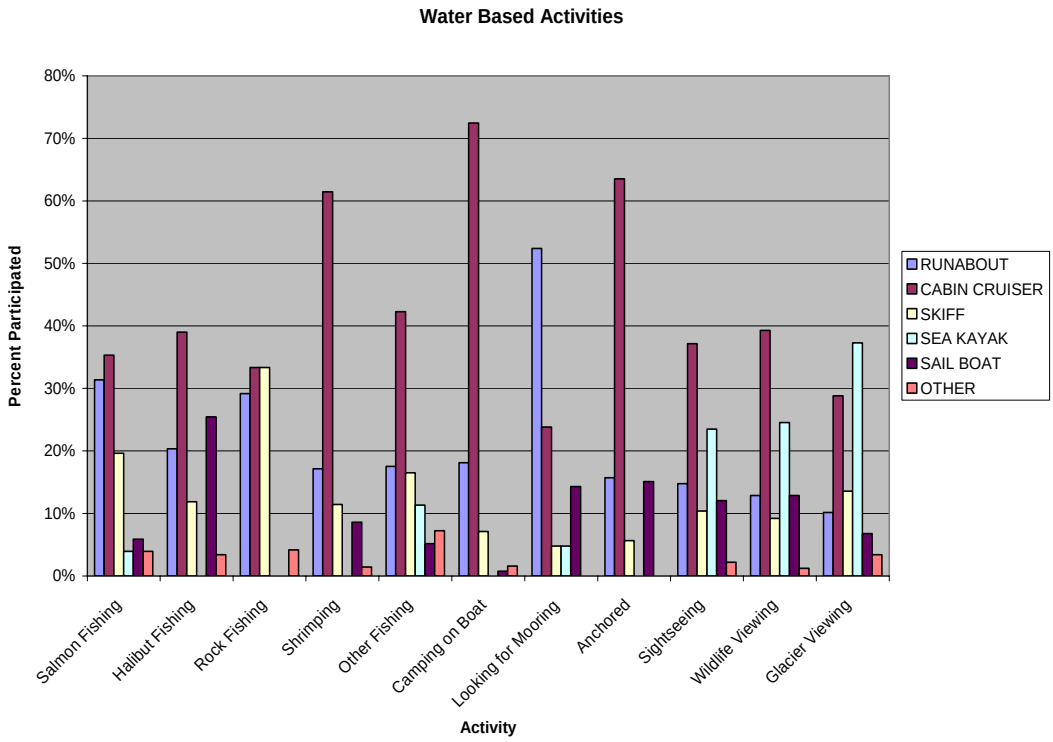


Figure 8: Proportion of use in water-based activities

Figure 9 shows proportion of use for land-based activities based on vessel type. The Chugach National Forest has expressed specific interest in identifying the

locations of land-based activities in order to evaluate the potential impacts recreation users may have on the land. A total of eight different land-based activities were identified by respondents. Users in cabin cruisers represented the highest participation in six of the eight categories. In both the deer and other hunting categories they dominated the use with 68% and 70% respectively. Sea kayakers were the primary user group that camped on land, representing 45% of the total use; they did not report any participation in any of the three hunting categories. Users with skiffs reported the highest number of stays in cabins and were well represented in all categories. As with the water based activities, users of vessels in the "other" category reported low participation in all categories other than deer hunting, where they represented the same number as skiff users. Sail boat users, as with sea kayakers, reported no use in any of the hunting categories. They represented just over 20% of the beach combing use.

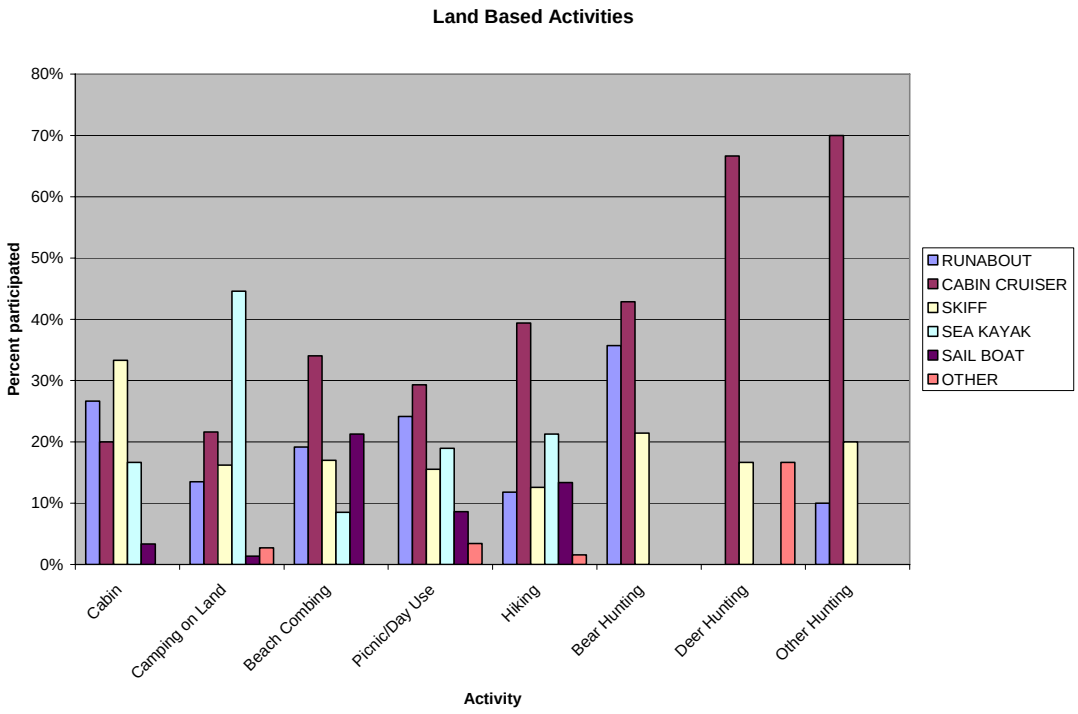


Figure 9: Proportion of use in land-based activities.

4.7 Overview of Statistics for Text-Based Data

This section is intended to be an overview of the more salient portions of the text-based portion of the survey. The responses highlighted here should provide background information on the respondents of our sample. A complete breakdown of all of the survey questions can be found in Appendix E.

The survey was targeted at users participating in either recreation or subsistence activities in the Sound. Individuals who identified as engaged in commercial activity were excluded from the sample. Respondents were asked to indicate if their primary purpose was subsistence, recreation or other. They were allowed to check all that applied, therefore the percentages may sum to greater than 100. It is not surprising that 92% of the respondents reported recreation as the primary purpose for their visit to the Sound. A total of 14% reported subsistence as the primary purpose while 8% reported some other activity as their primary purpose for visiting the Sound. The list of responses in the 'other' category includes such activities as sightseeing, R&R and enjoying the outdoors, all of which could be considered recreation activities. As a result primary participation in recreation activities could conceivably be higher than 92%. Additionally, 4% of respondents reported exclusive participation in subsistence activities, 79% reported exclusive participation in recreation activities and 2% reported exclusive participation in "other" activities.

Eighty-five percent of the respondents were Alaska residents. Of the 14% that were non-Alaskan residents, 25% reported that their current trip was their first trip to Alaska for recreation purposes. Likewise, 25% reported they had visited Alaska for recreation purposes 1-5 times in the past, 30% reported 6-10 times and 38% had visited 11 or more times for recreation purposes. Additionally, 46% of the non-residents reported that their current boating trip in the Sound was their first. Conversely, only 6% of the Alaskan residents reported that their current trip in the Sound was their first.

Participants were also asked "Since leaving home on this trip, has Prince William Sound been your only destination, the primary destination or just one destination out of several with equal or greater importance?" (Appendix E) Seventy-one percent reported PWS as their only destination while 16% reported it as their primary destination and 12% reported that PWS was one of several destinations.

A number of questions addressed respondents' recreation behavior and characteristics. Respondents were asked "About how much time in total will you be away from your home on this trip?" Ninety-four percent of the respondents answered this question. Responses ranged from 0 to 300 days, the median being 3 days. The survey also asked, "About how much money do you spend in a typical year on recreation or subsistence activities, including travel, equipment, membership and licenses?" Eighty-eight percent answered this question. Responses ranged from $100 to $50,000 with a median of $3,000. Question D3 asked respondents about how they were paying for their trip. Ninety-four percent of respondents answered this question. Of those, 40% reported that they were sharing expenses, 25% were paying for their own trip, 4% had someone else paying for their trip, and 31% reported paying for themselves as well as others. Of those who were paying for themselves as well as others, the number of other people ranged between 1 to 15 people. The median number of people paid for was 2 people.

Question D4 asked respondents to report the amount of money they spent on their current recreation trip. However, based on the responses given, detailed below, it appears that some respondents provided spending totals that were based on trips not limited to their current recreation trip in the Sound. Because spending in some categories, gasoline for example, totaled $10,000; we assume respondents were providing spending totals for a larger, more extensive, trip (such as for their entire trip to Alaska). Overall 86% percent of the respondents answered question D4. Table 13 illustrates the amount of money spent in each of the 9 categories of spending. Since respondents only reported spending in applicable categories we report spending patterns in two different formats. The first four columns provide the number, averages

and minimum and maximum of the reported expenditures. The final column provides the averages based on the entire sample of all 582 respondents who answered some portion of this question. The first method tells us how much people who purchased these goods spent, on average. The second method provides the overall sample averages, which could be used to estimate spending for the population of recreation users of PWS.

Table 13: Spending patters of respondents

	Number of Reported Expenditures	Average Reported Expenditures	Minimum Reported Expenditures	Maximum Reported Expenditures	Overall Sample Average n=582
Government owned lodging	33	$152	$10	$800	$7
Privately owned lodging	85	$639	$2	$7,000	$82
Food/drink at restaurants/bars	305	$149	$3	$3,000	$68
Gasoline and oil	522	$266	$2	$10,000	$207
Other transportation	188	$240	$2	$4,500	$68
Activities, guide fees, and equipment rentals	85	$487	$6	$6,000	$63
Recreation use fees	181	$60	$5	$800	$16
Souvenirs	55	$208	$10	$2,000	$17
Amount spent on "Other"	176	$106	$2	$1,500	$28

Based on our sample, 90% of the respondents who answered question D4 listed spending money on gasoline and oil, the category with the highest response. Responses ranged from $2 to $10,000 and averaged $266. The $10,000 response could be considered an outlier; the next highest single amount listed totaled $5,000. However, we chose to include this since it appears that respondents interpreted this question to include their overall trips to Alaska. Spending in other categories appears plausible and should provide an overview of on what and how much respondents spent. Since respondents appeared to interpret this question in different ways we urge caution on any attempts to extrapolate data based on the results presented here.

Several demographic questions were asked. Based on our sample 70% reported being male, while 25% reported female—5% did not answer this question. Participants were also asked about their race/ethnicity. The majority (87%) of respondents are white, with minimal representation in the other categories. (See Appendix E) Finally, a question about annual household income was asked. Twenty-

four percent reported earnings between $100,000 and $149,000. Additionally, 13% reported earnings of over $150,000.

4.8 Summary

The intent of this chapter is to provide details about the sample. Due to both the sample and return rates being relatively low, the results of this study should be cautiously applied to the larger population of recreation and subsistence users of Prince William Sound. However, broad patterns of use as well as identifying popular destinations, as discussed in chapter 5, do provide valuable information about the use that is occurring in the Sound.

The total population of recreational users of Prince William Sound is unknown. However, we sampled 27% of users on the days we distributed surveys at three harbors, with 31% surveys returned. Return rates are low, likely due to the degree of difficulty of the survey i.e., the length of time required to complete the survey. Additionally, survey crews received comments from possible respondents, stating they had recently participated in numerous surveys and were therefore less willing to accept our survey. Finally, during the short interview process, possible respondents often commented on the quality of the map and expressed interest in obtaining a copy; surveys may not have been returned due to participants keeping the survey because of the map. The survey return rate was less than required to allow us to reliably generalize these results to the total population of the Sound; however relative patterns of recreational use are expected to hold.

Chapter 5 Importance Performance Analysis

Limited data exist on how recreation users of Prince William Sound evaluate the management efforts of the Chugach National Forest. As such, this chapter examines user satisfaction in relation to various attributes of the Sound. Importance-Performance (IP) analysis intersects users' ratings of the importance resource attributes and management's performance in providing for these attributes. IP analysis is a tool that is used to evaluate people's satisfaction levels and has been applied in a variety of fields including health care, marketing, tourism and recreation. In the field of recreation, IP analysis has been used to evaluate the satisfaction of attributes associated with visitor centers (Megnak, Dottavio, & O'Leary, 1986), state park cabins (Hollenhorst, Olson, & Fortney, 1992), and alpine ski area (Hudson & Shepard,1988) among others. This section discusses the evaluation of different features within Prince William Sound by recreation users surveyed as part of the Prince William Sound Human Use Study conducted in the summer of 2005.

5.1 Importance Performance Background

IP analysis was initially developed by Martilla and James (1977) for use in measuring client satisfaction with products or services and their delivery. The analysis is comprised of two components: the importance of a product or service to the user, and the performance of how the product or service is being managed by either the business or the government agency in charge.

One limitation of IP analysis is its inherent inability to determine if the expressed importance is due to the respondent placing positive or negative value on the attribute. For instance, a user could rate a facility as important because of favorable characteristics due to it being able to provide fueling or safety in the wilderness. However, a different user could rate the same facility equally important but due to negative reasons because he or she may consider that such a facility poses a negative impact on the wilderness characteristics of the resource.

IP analysis is relatively inexpensive to administer and can be interpreted with general ease, thus increasing its popularity. Therefore, it is often viewed as an

attractive and inexpensive option by recreation managers if they desire an evaluation of their programs when their time and budgets are limited. Typically respondents are asked to assess the importance and performance of each attribute on a five-point Likert Scale. Importance is measured on a scale of 1 (not at all important) to 5 (very important). Performance is measured on the same scale, 1 (poor performance) to 5 (excellent performance)

The common output of the IP analysis is a graph containing four quadrants with on performance the X-axis and importance on the Y-axis. The crosshairs are generally set at 3, or the neutral response. Each of the four quadrants represents an intersection of both high or low importance and excellent or poor performance based on the data. Traditionally these quadrants have been labeled "Keep up the Good Work," "Concentrate Here," "Low Priority," and "Possible Overkill" (Bruyere et al (2002))

The crosshairs may sometimes be moved from the neutral point in order to emphasize the importance or performance concerning a specific attribute. As Bruyere (2002; p. 85) points out there are two reasons to adjust the crosshairs; "One, adjusting the performance crosshair allows for setting the standard of quality that significantly exceeds neutral and therefore reflects a higher standard of service. Second, adjusting the importance crosshair allows for priorities to be more narrowly recognized."

As applications of IP analysis have progressed, some papers have called for segmentation of user groups that would allow managing agencies to address the concerns of each group more specifically. Since different user groups likely have different objectives for visiting an area, the information gathered without segmentation of user groups could end up being misleading and cause managers to base decisions on faulty information. For example, one group may favor the presence of cabins in a national forest, while another group may prefer a more natural setting. The agency would benefit from being able to distinguish between the preferences of different user groups.

5.2 Results

As discussed in Chapter 3, the survey instrument was designed so that behavior and preference questions were as specific as possible to the different user groups. However, a number of questions were identical for all three user groups. For these common questions, preferences ratings can be directly compared for each of the user groups. For example, both the cruising and the fisher/hunter versions contained questions addressing the lack of mooring facilities in the Sound. This question was not posed in the paddling version of the survey because these users do not need mooring facilities. Conversely, it was assumed that paddlers would have higher sensitivity to land based features and therefore were asked question specific to vegetation loss and human waste on shore. Analysis was run separately for each of the different groups.

The wording on our survey deviated slightly from the traditional scale. The importance rating in the survey ranged from 1, very important, to 5, not important. Instead of asking about the performance we asked respondent to assess their satisfaction with the different attributes. Satisfaction ratings ranged from 1, very satisfied, to 5, very unsatisfied. However, to maintain consistency with previous work in the field the responses were recoded so that the low scores for importance and satisfaction equaled 1 and the high scores equaled 5. The neutral point remained at 3, which is also where the crosshairs were set. Inverting the rankings and setting the crosshairs at neutral makes this application of IP consistent with the majority of applications presented in the literature.

5.2.1 Importance Performance analysis for the Cruising Subgroup:

Attributes that the cruising subgroup was asked about are listed in Table 14. The most notable finding is that none of the attributes was rated by visitors as unsatisfactory. Three of the ten attributes received mean ratings in the important/satisfied quadrant by users in this subgroup. Wilderness experience and amount of litter at onshore sites received mean importance ratings of 4.59 and 4.60 respectively, while the performance ratings for the amount of litter onshore was

slightly lower (4.20) compared to the wilderness experience (4.53). There was little variance in the responses for these attributes, such that there is no overlap into other quadrants. The amount of human waste at onshore sites received a mean importance rating of 4.47 and performance rating of 4.20, variance for this attribute was likewise small, up to 1.10, and did not result in the responses overlapping into other quadrants. The favorable ratings for these attributes indicate that the cruising group, on average, appears to place a high degree of importance on these attributes and are quite satisfied with how the attributes are being managed.

The remaining 7 attributes were rated in the satisfied/not important quadrant; these attributes received lower importance ratings. However, performance, i.e. management actions, for these attributes were rated favorably. The lowest performance rating was given to the lack of fueling facilities[1] in the Sound (3.42) while the highest was given to the amount of non-motorized users within sight and sound of day-use areas (4.30). The performance rating for motorized and non-motorized use at both day-use and overnight sites ranged between 4.09 and 4.30, suggesting that this group is satisfied with the number of encounters they are experiencing. Based on our sample, the attributes that were rated in this quadrant represent attributes that are not as important to the users; however, they indicate a high degree of satisfaction with how these resources are being managed.

The cruising subgroup rated the attributes of the Sound in two of the four quadrants, the majority in the satisfied/not important quadrant and three attributes in the satisfied/important quadrant. After taking into account the standard deviations, the rating included the not important/not satisfied quadrant. The important/not satisfied quadrant did not receive any ratings. The relative size of the standard deviations demonstrates that for a majority of the attributes there is little agreement among

[1] The phrasing of this attribute as "lack of fueling facilities" is somewhat ambiguous and could be interpreted as either positive or negative, such that a low satisfaction rating could indicate that users regard the "lack of facilities" as an attribute in exess supply (i.e., too many fueling facilities). However, given that there are no fueling facilities outside of the three marinas, it is unlikely that respondents interpreted the question this way.

survey respondents' ratings they place on the importance of an attribute and the satisfaction they have with how the attribute is managed.

Table 14: Mean responses and standard deviations for the Cruising subgroup

	Importance	Performance
Litter at onshore sites	4.60 (0.80)	4.20 (1.03)
Wilderness experience	4.59 (0.76)	4.53 (0.79)
Human waste at onshore sites	4.47 (1.06)	4.20 (1.10)
Lack of fueling facilities	2.82 (1.60)	3.42 (1.49)
Motorized users within sight and sound at overnight use sights	2.76 (1.49)	4.09 (1.01)
Availability of cabins	2.41 (1.51)	3.48 (1.34)
Motorized users within sight and sound at day-use sights	2.40 (1.29)	4.15 (0.97)
Lack of mooring buoys	2.38 (1.52)	3.63 (1.35)
Non-motorized within sight and sound at overnight use sights	2.27 (1.30)	4.22 (0.96)
Non-motorized users within sight and sound at day-use sights	2.18 (1.26)	4.30 (0.92)

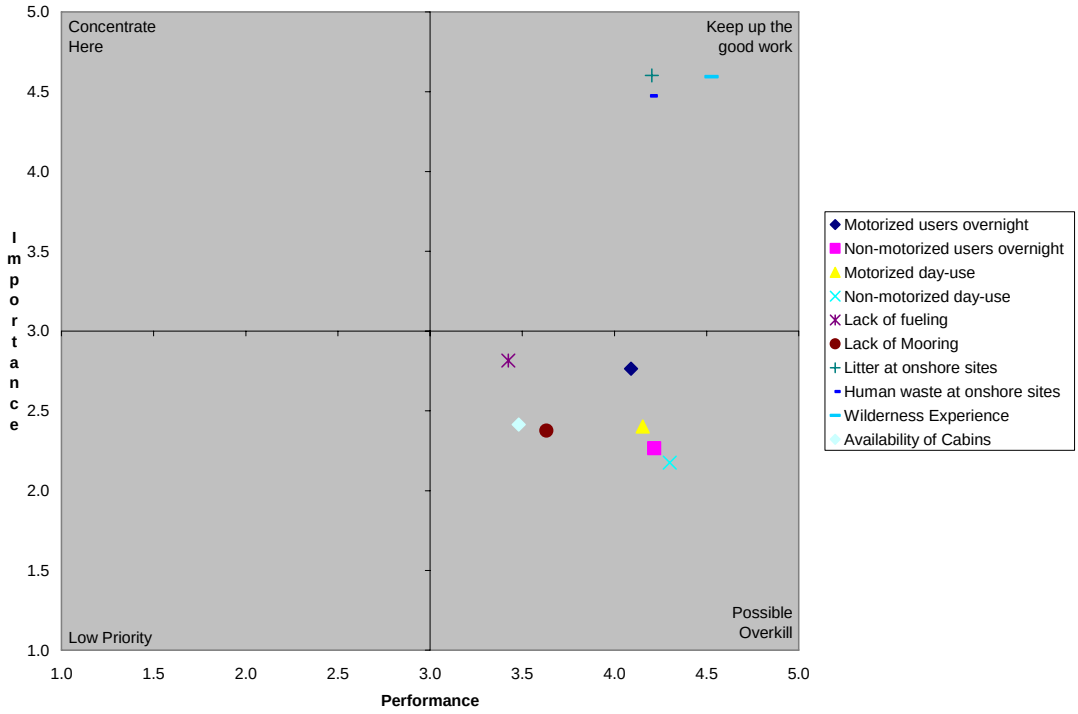


Figure 10: Importance Performance ratings of the Cruiser subgroup

5.2.2 Importance Performance analysis for the Paddling Subgroup:

The attributes listed for the paddling version of the survey varied slightly from those in the Cruising version. The Paddling subgroup rated 5 of the 10 attributes in the important/satisfied quadrant. Wilderness experience received the highest rating of all the attributes by this group; 4.92 for importance and 4.27 for satisfaction. The amount of litter at onshore sites received a mean importance rating of 4.84 and a mean satisfaction rating of 3.91. The ratings of these attributes will be compared with those of the other subgroups in section 5.2.4. Additionally paddlers rated the amount of vegetation loss at onshore sites and the number of motorized boats within sight and sound of overnight use sites in this quadrant. Paddlers appear to be pleased with the management of these attributes by placing them in the "Keep up the Good Work" quadrant.

The remaining 5 attributes were rated in the not-important/satisfied quadrant. Both, the amount of motorized and non-motorized boat use at day-use sites, were rated with the highest degree of importance in this quadrant, 2.88 and 2.84 respectively. Non-motorized users at overnight sites, the availability of cabins and the lack of fueling facilities were rated less important; however the performance ratings were higher. The lack of fueling facilities received a low importance rating (1.94) and the second highest performance rating (4.19) of all the attributes presented to the paddling subgroup. This indicates that paddlers are happy not to have fueling facilities available.

Consistent with the mean ratings of the cruising subgroup, the paddling subgroup also rated all of the attributes in either of the important/satisfied quadrant or the not-important/satisfied quadrant. However, after taking into account the standard deviations the attribute ratings for the paddling subgroup ranged into all four quadrants. The relative small standard deviations surrounding the mean ratings for the amount of litter and human waste onshore as well as the wilderness experience confined the ratings to the important/satisfied quadrant. This would indicate a fairly high level of agreement among paddlers that they are quite satisfied with these attributes. The standard deviation surrounding the mean rating for the lack of fueling facilities limited the ratings to the not important/satisfied quadrant. Since sea kayakers would have essentially no use for a fueling facility it is not surprising that they rated this attribute in the “possible overkill” category.

Table 15: Mean responses and standard deviations for the Paddling subgroup

	Importance	Performance
Wilderness experience	4.92 (0.39)	4.27 (0.98)
Litter at onshore sites	4.84 (0.42)	3.91 (1.22)
Human waste at onshore sites	4.78 (0.60)	4.20 (1.16)
Vegetation Loss	3.94 (1.38)	3.96 (0.99)
Motorized users within sight and sound at overnight use sights	3.26 (1.62)	3.32 (1.30)
Motorized users within sight and sound at day-use sights	2.88 (1.52)	3.35 (1.21)
Non-motorized users within sight and sound at day-use sights	2.84 (1.50)	3.43 (1.32)
Non-motorized within sight and sound at overnight use sights	2.63 (1.41)	3.92 (1.12)
Availability of cabins	2.34 (1.56)	3.86 (1.27)
Lack of fueling facilities	1.94 (1.59)	4.19 (1.35)

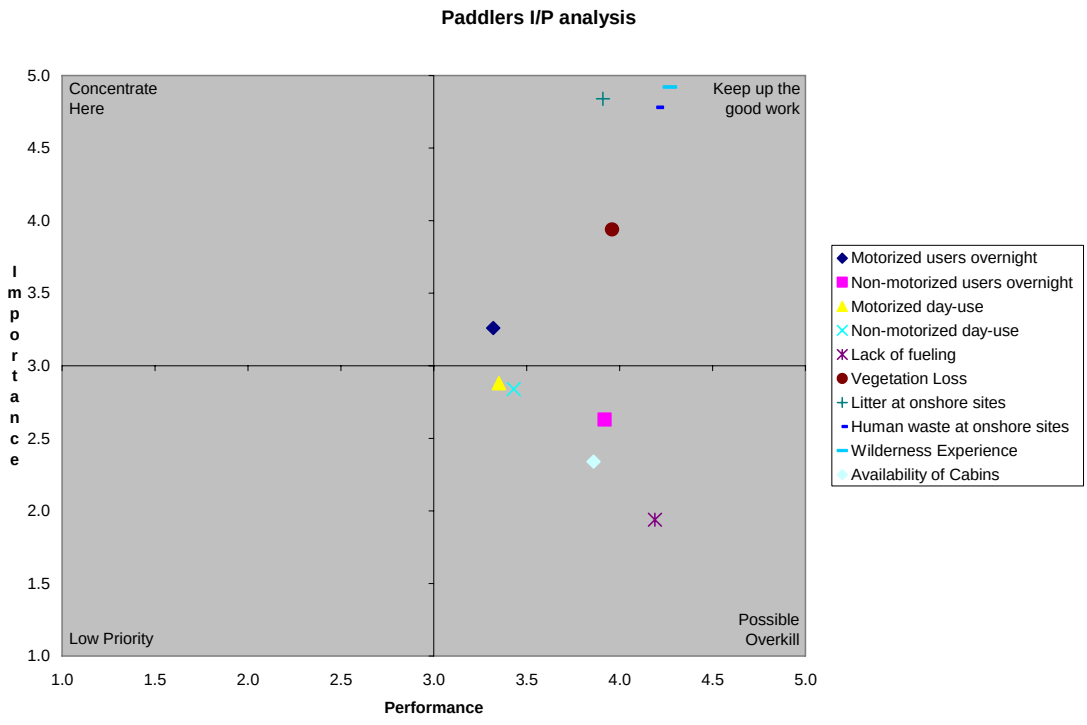


Figure 11: Importance Performance ratings for the Paddling subgroup

5.2.3 Importance Performance analysis for the Fisher/Hunter Subgroup:

The fisher/hunter version of the survey included 14 attributes, 9 of which were rated in the important/satisfied quadrant. Four attributes were rated in the not-important/satisfied quadrant and one, the availability of mooring facilities, was rated in the important/not-satisfied quadrant with average importance and performance ratings of 3.01 and 2.98 respectively. The mean ratings for harvest limits (4.04 importance, 3.88 satisfaction) and the fishing catch rate (3.93 importance, 3.48 satisfaction) places these attributes in the important/satisfied quadrant. The hunting success rate received a mean importance rating of 2.83 and a satisfaction rating of 2.48 placing it in the important/satisfied quadrant. These ratings would suggest that the fisher/hunter group is generally satisfied with the fishing regulations.

The availability of cabins received an average of 2.69 importance and 3.05 rating by this user group. With a slight drop in the satisfaction rating this attribute would be rated in the not important/not satisfied quadrant. The ratings for all of the attributes in the not-important/satisfied quadrant are within half a point of changing to a different quadrant. Because of the limited sample size these rating could fall into different quadrants if sampling were to be repeated.

However, after taking into account the standard deviations the attribute ratings for the fisher/hunter subgroup ranged into all four quadrants. The wilderness experience was the only attribute that received ratings in a single quadrant, the important/satisfied quadrant. The remaining attributes were rating in multiple quadrants with most of them receiving ratings in each of the four quadrants. This would indicate that for a majority of the attributes there is little agreement among the fisher/hunter subgroup.

Table 16: Mean responses and standard deviations for the Fisher/Hunter subgroup

	Importance	Performance
Wilderness experience	4.53 (0.77)	4.39 (0.86)
Litter/waste at onshore sites	4.18 (1.29)	3.94 (1.17)
Harvest limit	4.04 (1.18)	3.88 (1.06)
Fishing catch rate	3.93 (1.13)	3.48 (1.19)
Other users at overnight sites	3.64 (1.28)	3.64 (1.05)
Availability of fueling facilities	3.42 (1.52)	3.31 (1.38)
# of recreational boater at day use areas	3.36 (1.32)	3.63 (1.02)
# of non-commercial fishers at day use areas	3.33 (1.36)	3.75 (0.92)
# of commercial fishing	3.25 (1.48)	3.29 (1.28)
Availability of mooring facilities	3.01 (1.60)	2.98 (1.37)
Hunting success	2.83 (1.66)	3.48 (1.19)
# of hunters at day use areas	2.77 (1.54)	3.44 (1.12)
Absence of developed sites	2.75 (1.61)	3.59 (1.27)
Availability of cabins	2.69 (1.59)	3.05 (1.30)

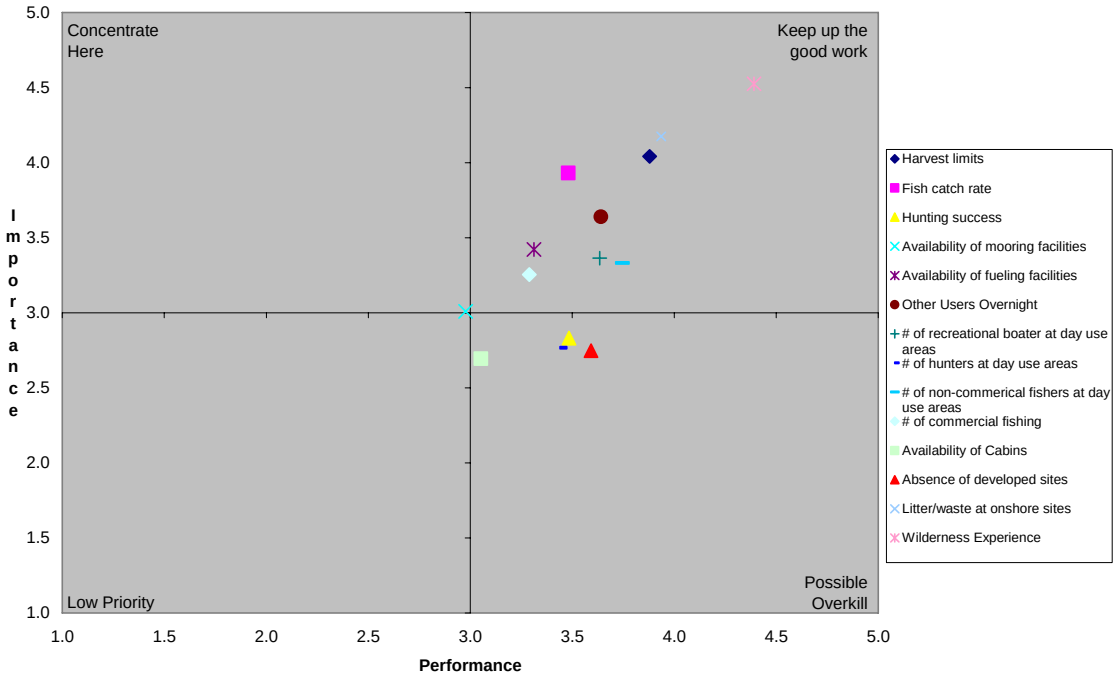


Figure 12: Importance Performance ratings for the Fisher/Hunter subgroup

5.2.4. Comparing the Importance Performance ratings between all three subgroups

This section focuses on comparing importance and performance ratings of the three questions that were identical among the three different user groups. All three groups rated the availability of cabins in the not-important/satisfied quadrant. As discussed earlier, the fisher/hunter group rating for the availability of cabins is close to dropping into the not-important/not-satisfied, while the other two user groups rated their satisfaction with the availability of cabins higher. The amount of litter at onshore sites was rated in the important/satisfied quadrant by all three groups. Paddlers rated this attribute the highest on importance (4.84), while fisher/hunters rated it the lowest (4.18). However both these groups rated their satisfaction with this attribute very similar, paddlers 3.91 and fisher/hunter 3.94. The wilderness experience ratings for all three groups were in the important/satisfied quadrant, and grouped relatively close together.

Table 17: Mean responses and standard deviations for equivalent questions for all three subgroups

Attribute	Cruisers		Paddlers		Fishers/Hunters	
	I	**P**	**I**	**P**	**I**	**P**
Litter at onshore sites	4.60 (0.80)	4.20 (1.03)	4.84 (0.42)	3.91 (1.22)	4.18 (1.29)	3.94 (1.17)
Wilderness experience	4.59 (0.76)	4.53 (0.79)	4.92 (0.39)	4.27 (0.98)	4.53 (0.77)	4.39 (0.86)
Availability of cabins	2.41 (1.51)	3.48 (1.34)	2.34 (1.56)	3.86 (1.27)	2.69 (1.59)	3.05 (1.30)

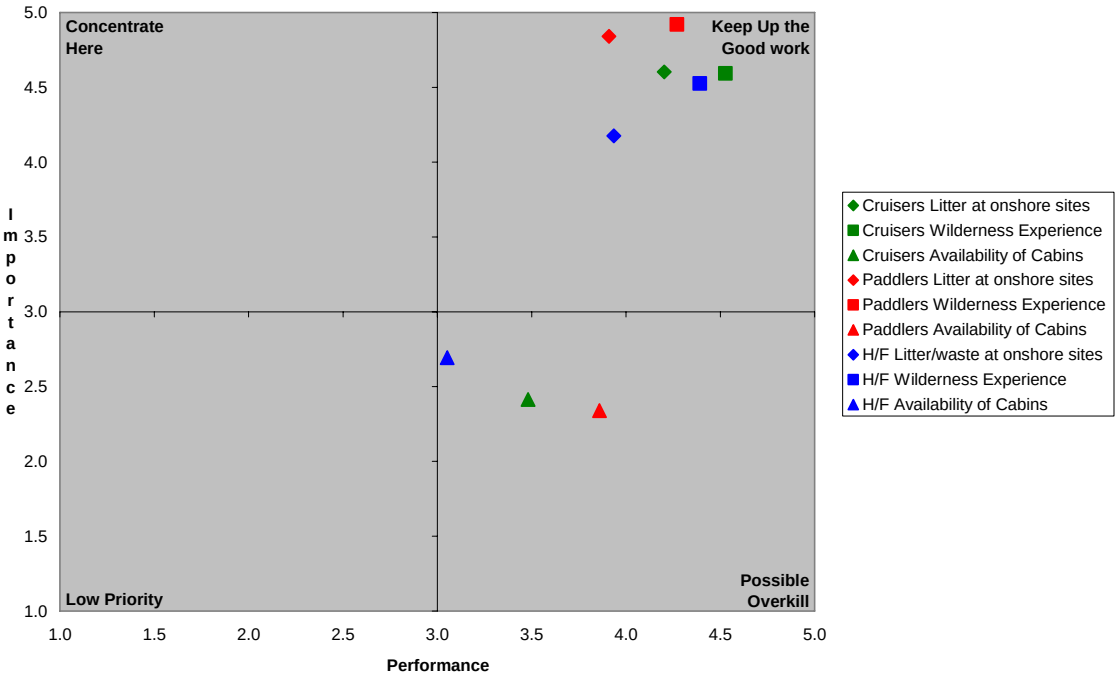


Figure 13: Importance Performance ratings for equivalent questions for all three subgroups.

5.2.5 Comparing the Importance performance Ratings of the Cruiser and Paddling Subgroups

This section focuses on how the importance performance ratings compare between the Cruising and Paddling subgroups. The two versions of the survey included 5 identical questions about attributes of the Sound. Both groups rated all of the attributes in the not-important/satisfied quadrant with the exception of motorized users within sight and sound of overnight sites being rated in the important/satisfied quadrant by the paddling group. On average the cruising group rated their satisfaction with how the USFS in maintaining these attributes higher than the paddling group. The lowest rating of satisfaction by cruisers was the lack of fueling facilities in the Sound. This makes sense since cruisers would be more likely to benefit from a fueling facility as opposed to paddlers who do not require such facilities. Additionally, paddlers may view a fueling facility as a disturbance to their wilderness experience. As we observed in the previous section, the rating for the wilderness experiences was not uniform for three groups, i.e. the paddlers on average place higher importance on this attribute.

Table 18: Mean responses and standard deviations for equivalent questions for the Cruising and Paddling subgroups

Attribute	Cruisers		Paddlers	
	I	**P**	**I**	**P**
Lack of fueling facilities	2.82 (1.60)	3.42 (1.49)	1.94 (1.59)	4.19 (1.35)
Motorized users within sight and sound at overnight use sights	2.76 (1.49)	4.09 (1.01)	3.26 (1.62)	3.32 (1.30)
Motorized users within sight and sound at day-use sights	2.40 (1.29)	4.15 (0.92)	2.88 (1.51)	3.35 (1.21)
Non-motorized within sight and sound at overnight use sights	2.27 (1.30)	4.22 (0.96)	2.63 (1.41)	3.92 (1.12)
Non-motorized users within sight and sound at day-use sights	2.18 (1.26)	4.30 (0.94)	2.84 (1.50)	3.43 (1.32)

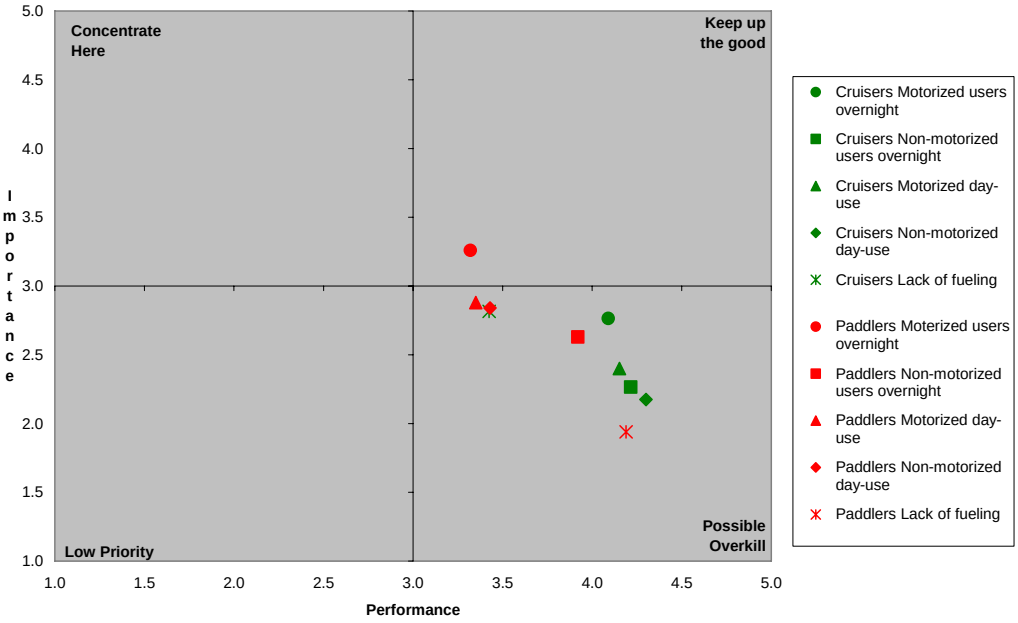


Figure 14: Importance Performance ratings of Cruiser and Paddlers subgroups

5.3 Summary

The survey design was segregated by user groups. Each version of the survey contained questions specific to a user group. For those questions that were presented to multiple user groups a comparison was made. Essentially all of the attributes were rated in either the important/satisfied (i.e., "Keep up the Good Work")or not-important/satisfied (i.e., "Possible Overkill") quadrants with the exception of the availability of mooring facilities by the fisher/hunter group which rated this attribute in the important/not-satisfied ("Concentrate Here") quadrant.

Two attributes were ranked highest in importance for all user groups—wilderness experience and litter onshore. Human waste onshore was ranked very high for the cruisers and paddlers, while fishers/hunters felt harvest limits and catch rates were of high importance. Interestingly, other than the fishing and hunting regulations, all of these attributes can be directly affected by how the Chugach National Forest manages their land resources. Many of the remaining attributes were not important to

our sample of users of the Sound. However, our sample of users seem to be satisfied with how these different attributes are being managed by the Chugach National Forest at current supply levels, with one exception (mooring facilities for the fishers/hunters group). Importance ratings vary between two quadrants. These differences were observed between attributes and user groups. However because the satisfaction ratings were high, the change in importance ratings only vary between important/satisfied (i.e., "Keep up the Good Work")and not-important/satisfied (i.e., "Possible Overkill") both of which are favorable ratings. Satisfaction ratings should be tracked over time as use levels in the Sound increase and the demographics and expectations of users potentially change.

While the mean ratings indicate the ratings of the attribute on average and are used in the literature to illustrate to managers the evaluation of people's satisfaction levels, they do not demonstrate the range of responses. The addition of standard deviations illustrates the range of rating for each of the attributes. Our results indicated that the ratings many of the attributes varied across the different quadrants. Attributes such as wilderness experience, cabin availability and litter at onshore sites were consistently rated in the important/satisfied quadrant by all three subgroups. Furthermore these ratings had relatively little variance around the mean, and consistently were confined to one quadrant. The variation around the mean for the other attributes was higher resulting in rating falling into three and often all four quadrants. This illustrates the low level of agreement among users in placing importance on, and evaluating the performance of, the attributes in the Sound.

The sample size also has an effect on the standard deviations. Of particular concern is the small sample size (59) for the paddling subgroup.

Chapter 6- Map Itinerary Data Summary

This chapter provides a detailed overview of spatial and temporal distributions for recreation use in the Sound based on the map itineraries data from the Prince William Sound Human Use Study. Recall, the map itinerary portion of the survey asked respondents to provide details about their current or most recent boating trip into the Sound, including tracing their travel route, identifying where they stopped, for how long and what activities they participated in at these stops. The primary tool for working with these data is ArcMap. The results presented in this chapter only reflect information from the sample. The data have not been expanded to represent the population of recreation users in the Sound. Therefore, we are assuming the sample is reflective of the relative levels of use for each harbor and user group.

6.1 Spatial Database Development

The analysis of the spatial data in ArcMap, as well as in RBSim, required digitizing the map data and creating a spatial database. Because the application of RBSim was part of the overall PWSHUS, the database needed to be set up in accordance with the RBSim formatting requirements. To ensure this, Environmental Systems Solutions in Victoria, Australia was contracted to create a web-based interface. The web-based interface allowed data to be entered remotely, i.e. by two work study students and the graduate student at Oregon State University. The resulting Microsoft Access Database was then transferred to a server at OSU were the analysis was conducted.

The web-based interface allowed the work study students to mimic the actual trip as closely as possible. This included the ability to distinguish respondents' primary stops (P1 &P2), for which they were asked subsequent questions, and all other stops. Since travel routes often meandered through the Sound or around geographical features, route markers were created. These route markers allowed links to be created between stops that provided a means for portraying the actual trip routes. At each stop, including P1 and P2, the ability to enter supplemental data was present. These

data included the arrival and departure times, activities participated in during the stop, and a text based description of respondent's comments about the stop.

Each of the returned surveys was given a unique numerical identifier before it was entered into the database. This allowed for a link between the spatial data and the text based data (see section 4.7), which included behavioral characteristics of the respondents. Trips were carefully reviewed before entry to ensure coherency within the trip. Data entry protocol called for the beginning and end of each trip to be identified with a stop consisting of a duration of 30 minutes, unless the respondents specified otherwise. Travel routes and stops were entered into the database to represent the trips depicted in the survey as accurately as possible. Some inaccuracies are unavoidable. First, the ability of the respondent to accurately trace their route as well as identify the specific locations of stops introduced some error. Second, some accuracy was lost as trips were entered into the database. These accuracy issues are minor and should have little effect on the analysis of the spatial data. Further discussion about mitigating these accuracy issues is provided in the following section.

6.2 Creation of Visitor Use Areas (VUA)

The next step was to spatially represent all of the 4,125 stops that were recorded in the trip itineraries. The distribution of visitor stops was not homogeneous throughout the Sound as illustrated in Figure 15.

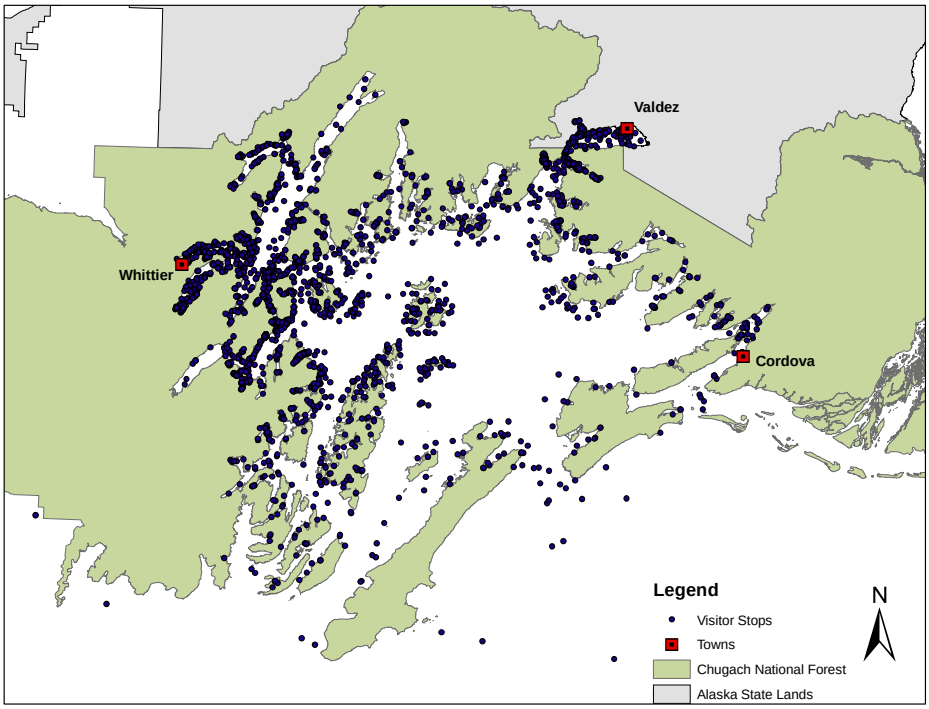


Figure 15: Stops and the aggregated travel network.

Analysis of each specific stop location is impractical and data intensive. Therefore, a spatial clustering technique was applied to aggregate these destinations into similar groups based on physical features such as bays and estuaries throughout the Sound. The spatial cluster analysis and creation of the Visitor Use Areas was conducted by Dr. Randy Gimblett at the University of Arizona. A complete discussion about the creation and justification of the Visitor Use Areas, as written by Dr. Gimblett, can be found in the Appendix C.

The spatial clustering produced 152 unique areas throughout the Sound, each of which was assigned a number for identification purposes. These areas will be referred to as Visitor Use Areas (VUA) for the remainder of this thesis. Figure 16 displays the 152 VUAs created. The Visitor Use Areas serve as the unit of analysis for much of the remainder of this chapter. Whenever possible the geographic names of locations in the Sound will be used.

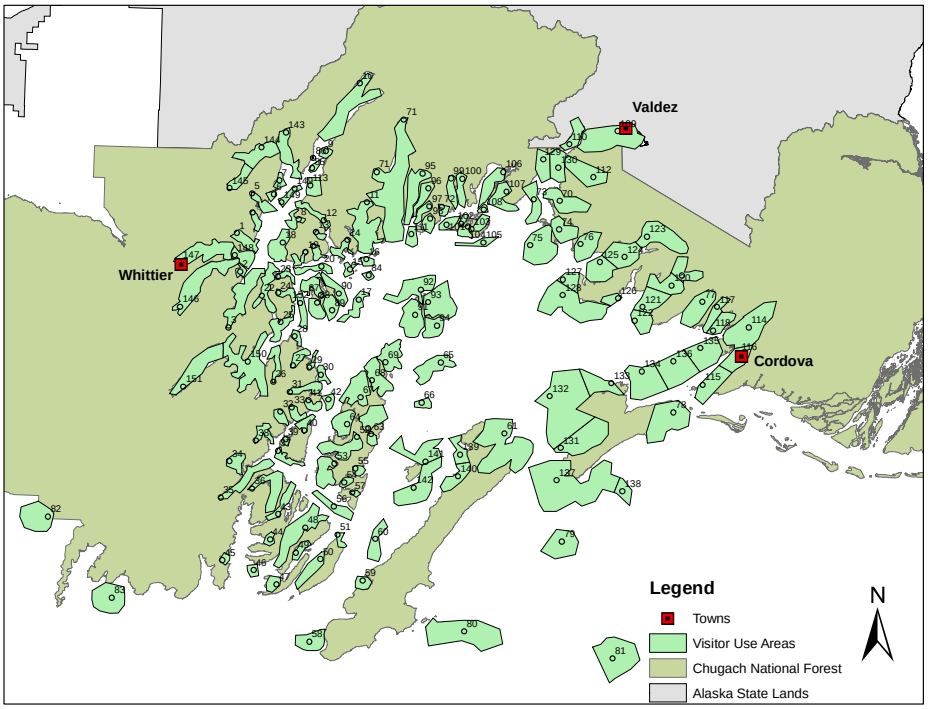


Figure 16: Location of Visitor Use Areas in Prince William Sound.

6.3 Differentiating Stops and Trips

As previously discussed, all stops were recorded for each of the trips entered into the database. This resulted in each stop being associated with a specific trip. As a result, it is possible to determine both the number of trips that entered into a VUA and the number of stops that occurred in a VUA. For example, if multiple trips stopped in a VUA, they would be identified by its unique trip number associated with each of the stops for that trip. However, it is also possible that a given trip stopped multiple times in a VUA. Each trip is counted once; however, it might produce multiple stops in a specific VUA. Analysis was done using both methods, number of trips and number of stops, for each of the VUAs in order to address different study objectives. For example, it is important for managers to be able to distinguish if multiple trips entered a VUA or if a single trip stopped multiple times in a VUA. The bulk of this chapter will be examining use based on both stops and the number of trips in a VUA. A

discussion about the difference between stops and trips will be presented whenever applicable.

6.4 Spatial Distribution of Use

The spatial distribution of use provides insight into many of the management issues of the Chugach National Forest. Sections in this chapter will focus on identifying VUAs that receive the most use. The next chapter will look at how recreation use relates to critical wildlife habitat.

In their study of human use in the Sound, Suring et al. (2004) developed a model based on "28 variables describing distance to and density of sites and characteristics of interest to water-borne recreationists in the western Sound…" (p.10). Their model showed similarities in the top-ranked variables among kayakers and motorized vessels. For kayakers it was important to minimize the distance to harbor and shore (i.e. avoid open water) and the distance to camp sites. Other characteristics that influenced kayaker distribution included glaciers, wildlife viewing opportunities and recreation sites such as trails. For motorized vessel users it was also important to minimize the distance to harbor. Other characteristics included the distance to anchor buoys and safe anchoring sites. The distance to shore was less important to this user group.

6.4.1 Sample Data for Prince William Sound

Number of Trips:

We begin by looking at the use for the entire recreation season. Figure 17 displays the intensity of the number of trips each VUA received from our sample over the entire season in 2005. The western Sound, particularly around Whittier, received the highest levels of use. Similar localized dispersion can be seen around both Valdez and Cordova. The least used areas are those that are more distant (remote) from the harbors.

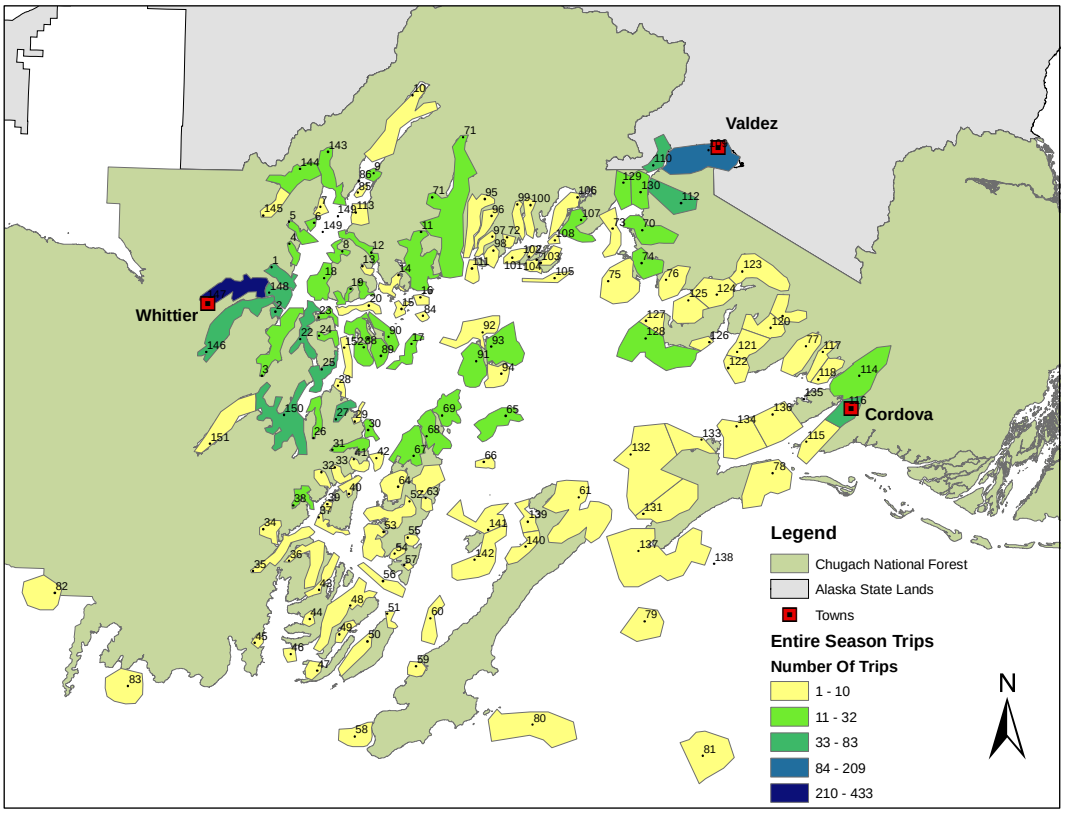


Figure 17: Visitor use over the entire season

Table 19 provides use levels over the season for the ten VUAs with the highest number of trips. A complete ranking of all VUAs based on total sample trips is provided in Appendix A. Only the top ten VUAs are included in Table 19 given use levels drop rapidly after this point. The last two rows in Table 19 show that 93% of the VUAs have fewer than 43 sample reported trips, with 37% of these (or 34% of the total VUAs) receiving less than 3 trips from the sample over the entire season. The top ten VUAs comprise nearly 50% of all trips reported by the sample for the entire season. VUA 147 and 109, which are the areas surrounding Whittier and Valdez respectively, received a majority of the use with about 29% of total trips reported. VUA 116, the area that includes Cordova, is ranked number 10. Of the remaining VUAs in the top ten, VUA 112, ranked 9th, is near Valdez. The rest of the VUAs in the top ten are near Whittier. Based on our sample data, the western Sound, which is

accessed primarily from Whittier, receives greater use than the eastern Sound. This is likely due to the proximity of Whittier to a major metropolitan area (Anchorage), whereas Valdez and Cordova are less accessible and remote from major metropolitan areas. A more detailed discussion of the other non-harbor VUAs will follow in subsequent sections.

Table 19: Ranked use of VUAs based number of trips

Rank	VUA	# of Trips	%
1	147	481	20.12%
2	109	212	8.87%
3	22	85	3.55%
4	25	64	2.68%
5	146	61	2.55%
6	148	60	2.51%
7	150	55	2.30%
8	1	52	2.17%
9	112	45	1.88%
10	116	45	1.88%
11-100		3-43	0.13%-1.80%
101-152		1-3	0.04%-0.13%

Number of Stops:

A second method of examining the use throughout the Sound is by looking at the dispersal of stops. This analysis provides different insight into the dispersal of use within the Sound than the number of trips entering a VUA. The number of stops provides a greater level of detail, since one trip can and likely does make more than one stop within a given VUA. Table 20 provides the top ten VUAs ranked by total number of stops recorded within them. Similar to describing trips, only the top ten VUAs based on total stops are displayed in Table 20; number of stops drops rapidly after this point. A complete ranking of all VUAs based on total sample stops is provided in Appendix A.

Table 20 Ranked use of VUAs based on number of stops

Rank	VUA	# of Stops	%
1	147	1097	27.50%
2	109	516	12.94%
3	150	151	3.79%
4	22	130	3.26%
5	146	105	2.63%
6	25	94	2.36%
7	1	80	2.01%
8	116	79	1.98%
9	148	72	1.80%
10	112	61	1.53%
11-100		4-60	0.10%-1.50%
101-152		1-4	0.03%-0.10%

Relative to the top ten VUAs based on trips, using stops identifies the exact same top ten, although their relative rankings change slightly. VUAs 147 and 109 remain the top two areas receiving the most use, accounting for about 40% of all reported stops. VUA 116, Cordova, is ranked 8th based on stops compared to its 10th rank based on trips. The remaining eight VUA's in the top ten accounted for about 19% of the stops, or when combined with the top two, the top ten account for nearly 60% of all reported stops for the entire season. The remaining 142 VUAs received minimal number of stops, between 1 and 60, throughout the season and accounted for approximately 40% of the overall stops.

6.4.2 Sample Data by Harbor

The total number of surveys distributed was discussed in the previous chapter. Table 21 illustrates the number of returned surveys and number of trips by harbor. The total number of trips exceeds the number of surveys because some respondents (< 10% of the sample) reported more than one trip (11% more trips than surveys).

Table 21: Number of surveys and number of trips by harbor.

	Returned Surveys	Number of Trips
Whittier	452	466
Valdez	163	204
Cordova	31	33

Similar methods for describing and evaluating sample data for the Sound will be followed when evaluating use originating from each harbor. The top ten VUAs based on trips and stops will be displayed and discussed. Complete data for all VUAs are available in Appendix A.

Whittier:

Figure 18 displays trips in the Sound for the entire season based on sample data for trips originating in Whittier. Use was concentrated near the point of origin, Whittier (VUA 147), although some trips extended across the Sound.

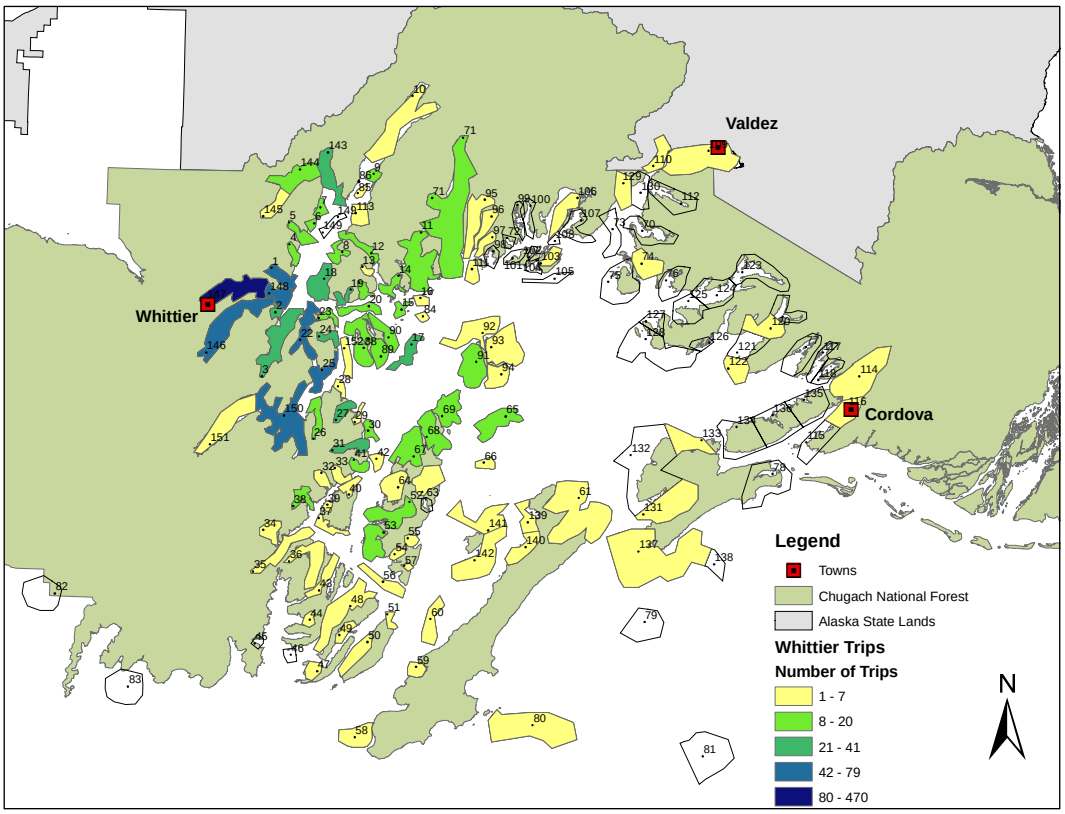


Figure 18: Number of trips originating from Whittier

Data on trips originating from Whittier show that 99 of the 152 VUAs (65%) were visited by the sample. Table 22 shows the top ten VUAs based on number of trips from the sample data. Overall the number of trips visiting the different VUAs appears to vary quite drastically. VUA 147 received the most trips, which makes

sense since it encompasses the city of Whittier. The second most visited area (VUA 22) encompasses the area known as Culross Passage, which is a narrow channel between the mainland and Culross Island. This is also the most direct route to access the Southern parts of the Western Sound. This would indicate that the passage is likely the chosen route of travel for users accessing the Sound from Whittier. The third most frequented area, VUA 25, is at the southern tip of Culross Island and likely receives many of the same trips that VUA 22 received. The next group of three VUAs received between 50 and 60 trips and are located either adjacent to or to the north of VUA 147. Beyond the top ten VUAs, use drops to below 32 trips and quickly tapers off to zero. The top ten VUAs account for 57% of the trips originating from Whittier.

Table 22: Ranked use of VUA based on number of trips by users from Whittier.

Rank	Visitor Use Area	# of Trips	Percentage
1	147	470	28.69%
2	22	79	4.82%
3	25	62	3.79%
4	148	59	3.60%
5	146	56	3.42%
6	1	52	3.17%
7	150	48	2.93%
8	27	41	2.50%
9	2	38	2.32%
10	3	33	2.01%
11-99		1-31	0.06%-1.89%

Table 23 provides the top ten VUAs based on number of stops for trips originating from Whittier. The top ten VUAs account for over 67% of the total stops reported by the sample of users accessing the Sound through Whittier. It is not surprising that VUA 147, containing the city of Whittier, ranks as the number one VUA, comprising over 40% of the stops. The second and third most visited areas, 150 and 22, each account for 4.5% of the total stops. Visitor Use Area 150 received the second most stops and is located further south in the Sound; i.e., it is not adjacent to or

in close proximity of Whittier. The fact that it received the second most stops but only the 7th most number of trips passing through it suggest that trips to this area stop more frequently than in other areas. When looking at the geographic features of this area, there are seven different bays associated with VUA 150, which may be a reason visitors stop more frequently within this VUA. Further analysis is needed to determine if bays within an area cause a higher frequency of stops to occur. Also, VUA 150 ranks as one of the largest in terms of acreage (Appendix B), which also could explain the higher number of stops. However, if this were the case, one might assume that it would also rank similar in number of trips. Visitor Use Area 22, Culross Passage, received 121 stops, and as mentioned before, this channel appears to be the preferred route of travel for boaters. However, the high number of stops likely indicates that visitors to this area are not simply passing through the channel, but instead stopping for a variety of reasons such as fishing or wildlife viewing. The locations in which visitors participated in activities such as these will be discussed in detail in section 6.4.4.

Table 23: Ranked use of VUA based on number of stops by users from Whittier

Rank	Visitor Use Area	# of Stops	Percentage
1	147	1076	40.41%
2	150	124	4.66%
3	22	121	4.54%
4	25	87	3.27%
5	146	82	3.08%
6	1	80	3.00%
7	148	71	2.67%
8	3	51	1.92%
9	27	51	1.92%
10	2	46	1.73%
11-100		1-35	0.04%- 1.31%
101-103		1	0.04%

Valdez:

Figure 19 displays trips in the Sound for the entire season based on sample data for trips originating in Valdez. Use was concentrated near the point of origin, Valdez (VUA 109), although some trips extended across the Sound. A total of 64 VUA's were visited by recreationists beginning their trips in Valdez.

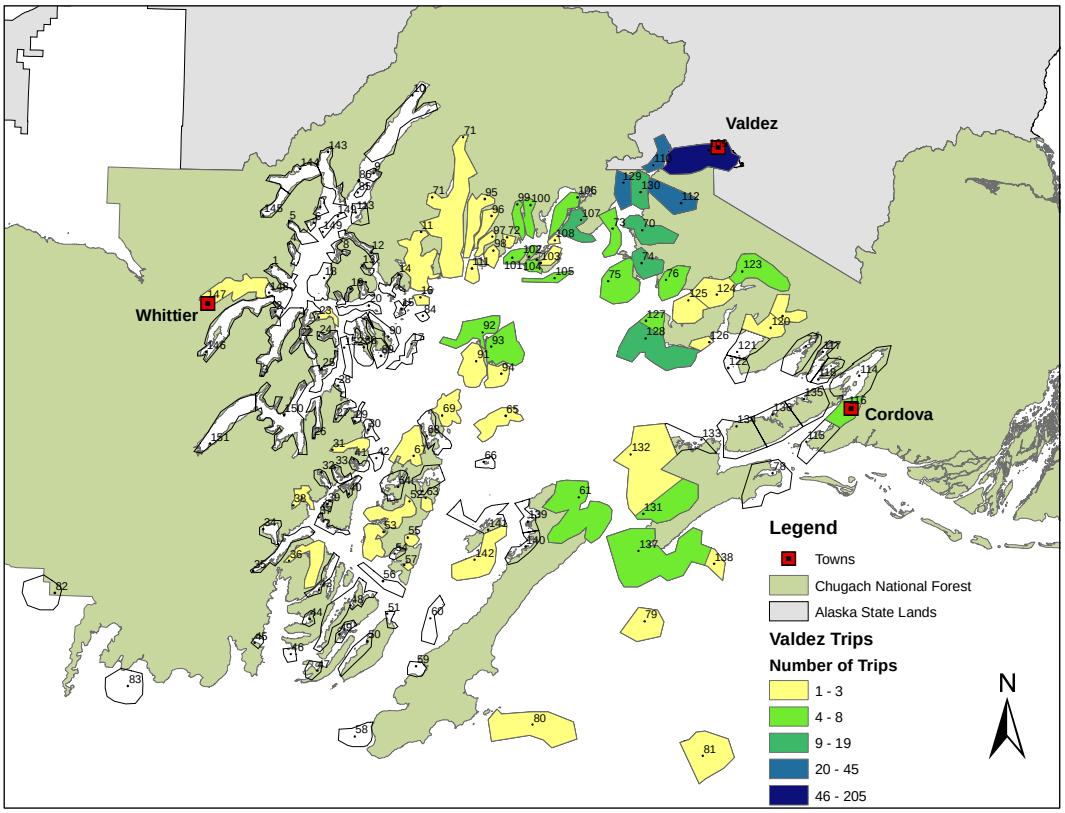


Figure 19: Number of trips originating from Valdez

Table 24 provides the top ten VUAs based on number of trips for the sample originating from Valdez. Our sample of users accessing the Sound via Valdez visited 42% of the VUAs (64 out of 152). As with the trips out of Whittier, the VUA containing the harbor (VUA 109) registered the most trips, or 36% of total sample trips. Use out of Valdez appears to follow a similar pattern where few VUAs receive the majority of use. The top ten VUAs account for 72% of total trips reported by the sample of users entering the Sound via Valdez. The next two VUA's received over forty trips each. VUA 112 encompasses Jack Bay, which is the only bay in the immediate area of substantial size and is located just south of the Port of Valdez. There are numerous reasons why this VUA might be frequented by recreation boaters. First, it is the closest bay to the Port of Valdez. Boaters wanting to visit another bay would have to traverse open water, which not all vessels are capable of safely doing.

Second, the bay contains attributes such as a USFS cabin and hiking trails. Lastly, based on conversations with fishing guides and users of the Sound (gathered during the intercept interview process), the area at the mouth of the bay is known for excellent salmon fishing.

The next most frequented area is the western portion of the Port of Valdez including the Valdez Narrows and Shoupe Bay (VUA 129). The narrows are equally renowned for their fishing potential and Shoupe Bay contains a tidewater glacier that is a significant tourist attraction. The remaining VUA's in the top ten are located south of the Valdez Narrows and encompass areas such as Bligh Island (VUA 75) and the Tatitlek Narrows (VUA 74) as well as the area around Heather Island (VUA 107), which is in the eastern portion of Columbia Bay. It appears that a majority of the trips that pass out of the Port of Valdez into the Sound stay along the shore on either the eastern or northern portion of the Sound, thus avoiding open water. The one exception to this rule appears to be Naked Island, which received up to eight trips based on the sample. However, this accounts for just over one percent of all the trips leaving Valdez.

Table 24: Ranked use of VUA based on number of trips by users from Valdez.

Rank	Visitor Use Area	# of Trips	Percentage
1	109	205	36.54%
2	112	45	8.02%
3	110	41	7.31%
4	129	31	5.53%
5	128	19	3.39%
6	70	16	2.85%
7	130	16	2.85%
8	107	13	2.32%
9	74	11	1.96%
10	73	8	1.43%
11-64		1-8	0.10%-1.43%

Table 25 provides the top ten VUAs originating from Valdez based on number of stops. The ranking is very similar to the analysis done on the number of trips entering a VUA, which suggests that trips are producing equal number of stops in the various VUA's. The second highest ranked VUA 112, Jack Bay reported 61 stops. As discussed earlier, this area is known for its fishing opportunities, which could explain the amount of stops. Visitor Use Area 110, Shoupe Bay, received the third highest number of stops, with 53. This area is known for both fishing and glacier viewing, both of which likely cause users to stop multiple times. The remaining VUAs in the top ten are located near the shoreline and do not require visitors to cross open water. Finally, 80% of all stops by visitors originating in Valdez occurred in the top ten VUAs; conversely the remaining 52 Visitor Use Areas only accounted for 20% of the stops.

Table 25: Ranked use of VUA based on number of stops by users from Valdez**.**

Rank	Visitor Use Area	# of stops	Percentage
1	109	509	52.91%
2	112	61	6.34%
3	110	53	5.51%
4	129	36	3.74%
5	130	22	2.29%
6	128	21	2.18%
7	70	19	1.98%
8	107	19	1.98%
9	76	15	1.56%
10	74	14	1.46%
11-62		1-11	0.10%-1.14%

Cordova:

Figure 20 displays trips in the Sound for the entire season based on sample data for trips originating in Cordova. Use was concentrated near the point of origin, Cordova (VUA 116), although some trips extended across the Sound. A total of 24 VUA's were visited by recreationists beginning their trips in Cordova.

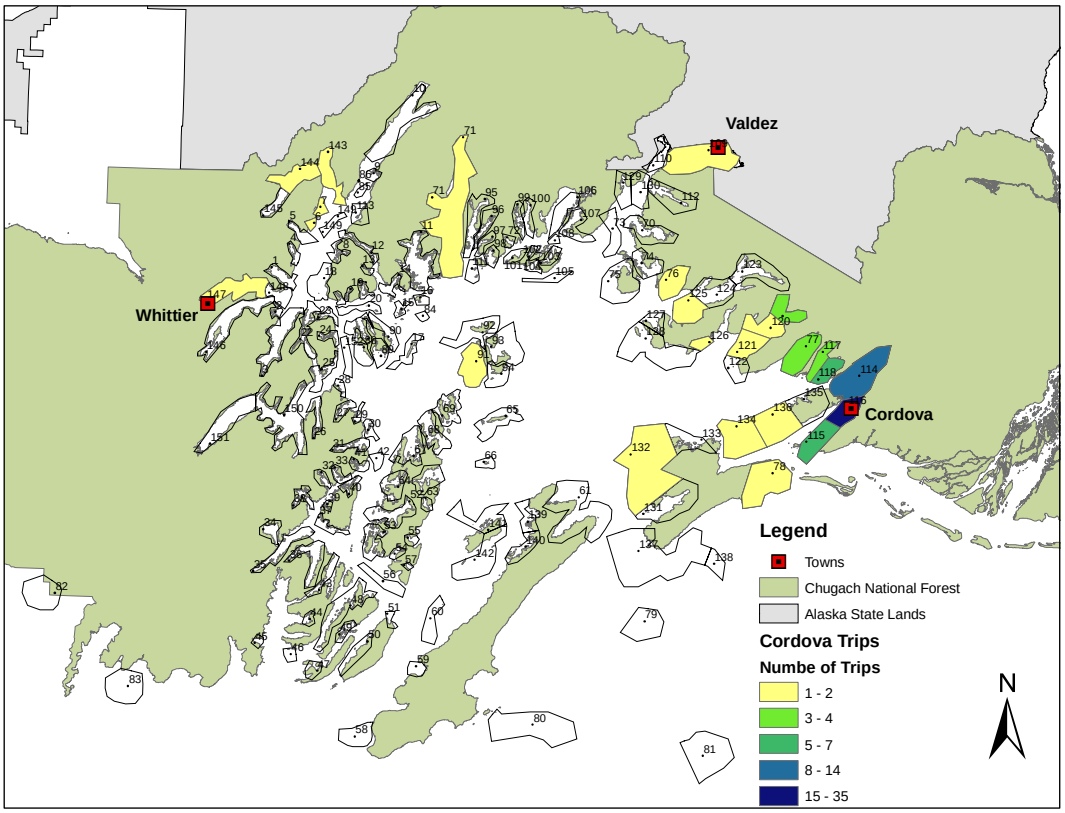


Figure 20: Number of trips originating from Cordova

Table 26 provides the top ten VUAs based on number of trips for the sample originating from Cordova. Our sample of users accessing the Sound via Cordova visited only 16% of the VUAs (24 out of 152). Even though the sample from Cordova was considerably smaller than either Valdez or Whittier, the same basic pattern is observed. A few VUAs received the majority of use while the others received very little. VUA 116 encompasses Cordova and received nearly 37% of total use based on the trips originating from Cordova. The area to the east of Cordova, towards Shepard Point (VUA 114), was the second most visited by recreational users with almost 15% of the trips reporting use there. The next most visited area included the south arm of Simpson Bay (VUA 118) with 7 trips entering the area. The area to the west of Cordova, towards Mummy Island (VUA 115), received just over 6% of the total trips. When looking at the geography of the area surrounding Cordova one notices that the

areas that lie beyond Simpson Bay to the north and Mummy Island to the west require crossing open water. As discussed earlier, these areas may not be receiving as much use for two reasons; travel time is greater and more constraining, and open water may be a deterrent because many vessels cannot safely traverse open water, especially given variable conditions on open water.

Table 26: Ranked use of VUA based on number of trips by users from Cordova.

Rank	Visitor Use Area	# of trips	Percentage
1	116	35	36.84%
2	114	14	14.74%
3	118	7	7.37%
4	115	6	6.32%
5	77	4	4.21%
6	117	4	4.21%
7	119	4	4.21%
8	78	2	2.11%
9	121	2	2.11%
10	134	2	2.11%
11-24		1-2	1.05%-2.11%

Table 27 provides the top ten VUAs based on number of stops for the Cordova sample. Similar to the relationship between trips and stops in both Whittier and Valdez we observe the same VUA pattern in Cordova. The only exception being VUA 134 which is not included in the table of stops; VUA 144 appears instead. This is interesting considering that VUA 144 is part of Harriman Fjord located in the vicinity of Whittier. However the sample from Cordova is very small and VUA 144 shows up in the list with only 3 total stops occurring in it. If we look at the full table of trips in each VUA (see Appendix A) we see that only one trip originating from Cordova visited VUA 144. Finally, 88% of all stops by visitors originating in Cordova occurred in the top 10 VUA's.

Table 27: Ranked use of VUA based on number of stops by users from Cordova.

Rank	Visitor Use Area	# of Stops	Percent
1	116	67	43.23%
2	114	20	12.90%
3	121	11	7.10%
4	118	9	5.81%
5	115	7	4.52%
6	77	6	3.87%
7	119	5	3.23%
8	78	4	2.58%
9	117	4	2.58%
10	144	3	1.94%
11-24		1-3	0.65%-1.94%

6.4.3 Sample Data by User Group

This section provides an overview of user trips and stops based on user type. Similar methods for describing and evaluating sample data for the Sound will be followed when evaluating use originating from each harbor. The top ten VUAs based on trips and stops will be displayed and discussed. Complete data for all VUAs is available in Appendix A. Fishers/hunters comprise 65% of the observations (n=433), while Cruisers make up 26% (n=176) and Paddlers 9% (n=59). This section will focus on the dispersal of use for these subgroups based on our sample data, highlighting how these user groups differ from one another.

Paddlers:

Figure 21 displays trips in the Sound for the entire season based on sample data from the Paddlers subgroup. The Paddlers subgroup consists mostly of sea kayaks. The majority of the paddlers originated from Whittier (VUA 147) and stayed in that general area. The second largest harbor with paddling use reported by the sample included Valdez, although use levels here are quite small. Paddling use from Cordova is virtually non-existent based on the sample data.

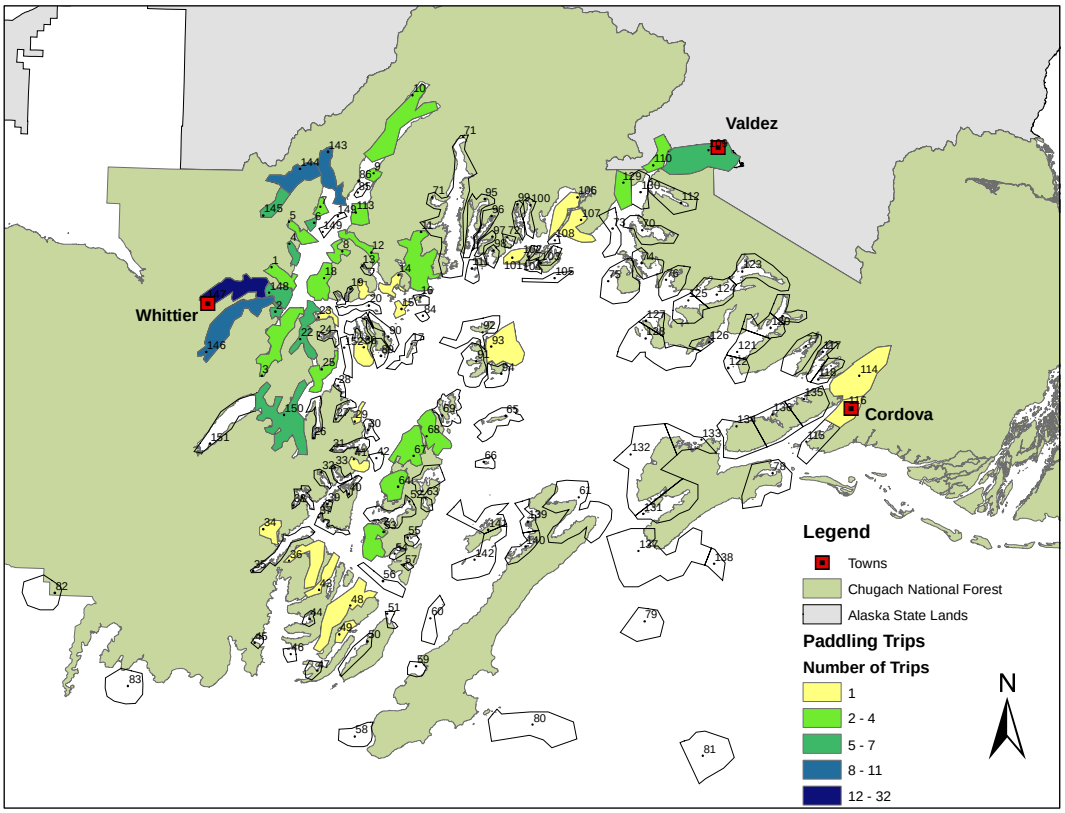


Figure 21: Number of trips taken by Paddling subgroup.

Table 28 and Table 29 lists the top ten VUAs based on paddling use (trips and stops, respectively) in our sample for the Sound over the season. Paddlers visited about 32% of the VUAs. Most of these visits originated from Whittier (VUA 147) and stayed in the general area. The top ten VUAs account for 57% of all paddling trips and 71% of the stops reported by the sample. Since these vessels are human powered, both their range of travel and ability to access various areas of the Sound are limited. Although a majority of the trips originated from the harbors, we observed trips in which paddlers chartered boats to transport them to remote locations in the Sound where they would begin or end their sea kayaking trip.

A popular destination for paddlers accessing the Sound from Whittier appears to be the Harriman Fjord (VUA 144) and Barry Arm (VUA 143) areas located in the northern part of Port Wells. These two VUAs ranked 2nd and 3rd, respectively, for number of trips and 2nd and 4th, respectively, for number of stops. It is, however,

difficult to ascertain if these are separate trips (due to the fact that these are adjacent areas) or whether both VUAs were visited on the same trip. Since the VUA's between the harbor and VUAs 144 and 143 did not receive as many trips, it is safe to assume that many of the paddling trips in the Barry Arm and Harriman Fjord areas hired water taxis. The Harriman Fjord (VUA 144) received 40 stops in it while the Barry Arm (VUA 143) only received 28 stops. This may indicate that there are more sightseeing possibilities in Harriman Fjord. Another popular destination, Blackstone Bay (VUA 146), lies to the south of Whittier and received close to 6% of the trips. There are several tidewater glaciers located at the head of the bay that may be attracting visitors.

Paddling use originating from Valdez appears to be a bit more limited. Other than the Port of Valdez (VUA 109), only Shoupe Bay (VUA 110) and Sawmill Bay (VUA 129) appear to attract paddlers. VUA 110, which includes Shoupe Bay and the Valdez Narrows, is a popular destination because Shoupe Bay offers tidewater glacier viewing possibilities as well as hiking opportunities.

Paddling trips originating in Cordova are virtually non-existent based on our sample. Only one of the seven surveys distributed at Cordova to paddlers was actually returned. A plausible limiting factor to paddling near Cordova may be that taking a sea kayak to any other locations around Cordova would require considerably more time as well as likely having to enter larger, open water. However, sea kayaking does occur around Cordova as is evident from discussions with a local rental shop. Clients of the shop mostly begin their trips near Orca Bay Cannery located several miles north east of town. Since these trips do not begin their trip at either the harbor or the North Containment they were not targeted as part of this survey. The survey crew did provide surveys to the rental shop with the request that they be distributed to their clients. These surveys received unique identifiers because they were not part of the sampling plan; however, none of these surveys were returned.

Table 28: Ranked use of VUA based on number of trips by the Paddling subgroup

Rank	Visitor Use Area	Number of Trips	Percentage
1	147	32	18.39%
2	144	11	6.32%
3	143	10	5.75%
4	146	10	5.75%
5	6	7	4.02%
6	109	7	4.02%
7	145	6	3.45%
8	150	6	3.45%
9	2	5	2.87%
10	4	5	2.87%
11-49	22	1-5	0.57%-2.87%

Table 29: Ranked use of VUA based on number by stops for the Paddling subgroup

Rank	Visitor Use Area	# of Stops	Percentage
1	147	110	27.09%
2	144	40	9.85%
3	146	34	8.37%
4	143	28	6.90%
5	150	24	5.91%
6	109	15	3.69%
7	22	11	2.71%
8	110	11	2.71%
9	6	9	2.22%
10	114	8	1.97%
11- 49		1-7	0.25% -1.72%

Cruisers:

Figure 22 displays trips in the Sound for the entire season based on sample data from the Cruisers subgroup. Cruisers equally originated from Whittier (VUA 147) and Valdez (VUA 109). Cordova (VUA 116) is the third most heavily used VUA. However, once the Cruisers left the harbors, they quickly dispersed. Their vessels are well-equipped for crossing large water and staying out for several days.

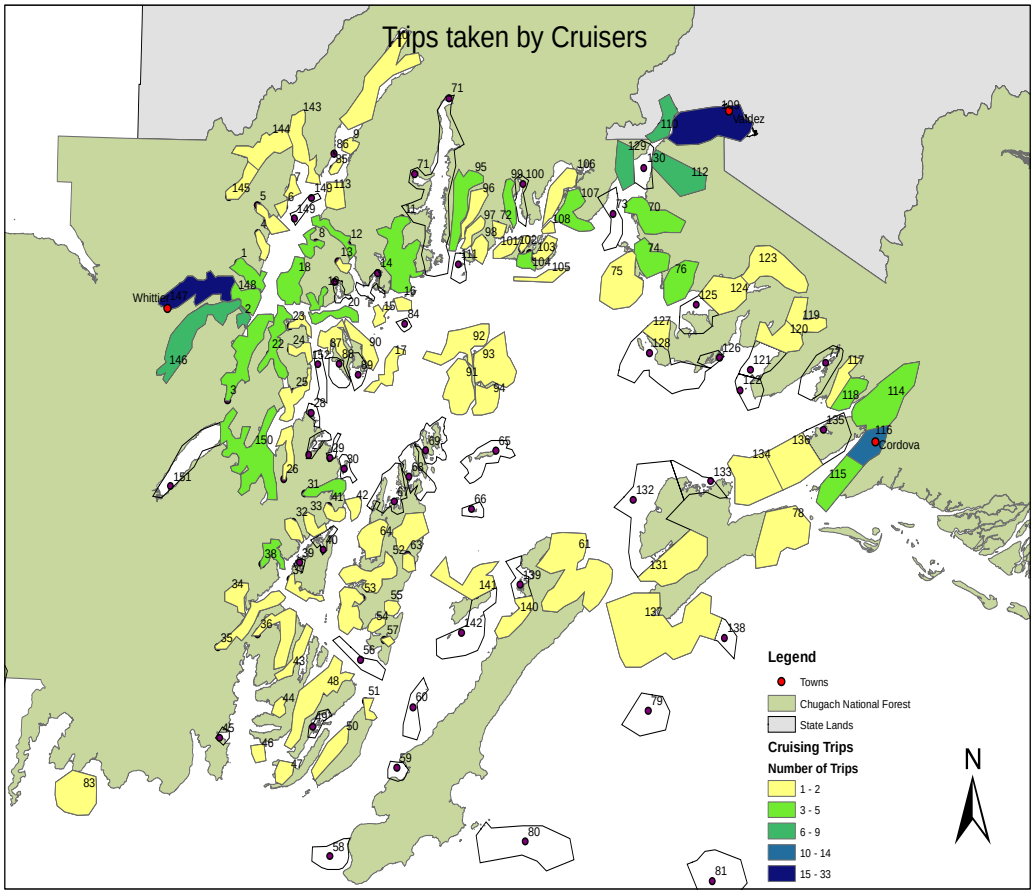


Figure 22: Number of trips taken by the Cruising subgroup.

The Cruisers subgroup consists of both motorized vessels and sail boats that typically include on-board sleeping accommodations. In general, it is expected that these users would participate in multi-day trips and spend time at cabins or hiking on land within the Sound. Tables 30 and 31 provide the top ten VUAs based on trips and

stops data, respectively, for the Cruiser subgroup. The top ten VUAs account for 41% of trips and 47% of stops for the Cruiser subgroup. Cruisers were more evenly distributed across the sound, visiting 69% of the VUAs.

Use originating in Whittier dispersed quite evenly around the immediate areas. Blackwell Bay (VUA 146) appears to be the primary destination for this group. However, some areas located further away from Whittier deserve to be mentioned. VUA 150, part of Port Nellie Juan, consistently appears in the top ten tables. There are several smaller bays in this VUA that could be attracting users. Eschamy Bay (VUA 31) and Jackpot Bay (VUA 38) also seem to be popular destinations for cruisers.

The use from Valdez also diminished with distance. The bays closest to Valdez, Shoupe (VUA 110), Jack (VUA 112) and Sawmill (VUA 129), received the greatest number of trips and stops visiting them. The other bays receiving trips include those that do not require crossing open water (e.g., VUAs 74 and 76); i.e., users tended to stay closer to the coast lines.

Cruiser use was limited in the areas surrounding Cordova. Trips appear to visit areas around Shepard Bay (VUA 114) and Hawkins Island, which encompasses VUAs 134, 135 and 136. It is possible that cruising trips originating in Cordova dispersed throughout the Sound.

As expected we see that cruisers disperse further than the paddling group; however, visitation seems to be concentrated to those areas that do not require crossing open water. The areas towards the center of Prince William Sound did receive limited use, but they were less frequented than other sites along the coast line.

Table 30: Ranked use of VUA based on number of trips by the Cruising subgroup

Rank	Visitor Use Area	Number of Trips	Percentage
1	147	33	11.04%
2	109	31	10.37%
3	116	14	4.68%
4	112	9	3.01%
5	146	8	2.68%
6	110	7	2.34%
7	129	6	2.01%
8	2	6	2.01%
9	150	5	1.67%
10	118	5	1.67%
11-100		1-5	0.33%-1.67%
101-105		1-1	0.33%-0.33%

Table 31: Ranked use of VUA based on number of stops by the Cruising subgroup

Rank	Visitor Use Area	Number of Stops	Percentage
1	147	69	14.44%
2	109	65	13.60%
3	116	26	5.44%
4	112	20	4.18%
5	150	15	3.14%
6	146	12	2.51%
7	110	11	2.30%
8	76	9	1.88%
9	114	9	1.88%
10	129	8	1.67%
11-100		1-7	0.21%-1.46%
101-105		1-1	0.21%-0.21%

Fishers/Hunters:

Figure 23 displays trips in the Sound for the entire season based on sample data from the Fishers/Hunters group. Fishers' and hunters trips originated most frequently from Whittier (VUA 147) followed by Valdez (VUA 109). Cordova (VUA 116) is the third most heavily used harbor, and ranked 8th with number of stops. The Cordova VUA does not appear in the top ten VUA's based on number of trips. Once the Fishers/Hunters left the harbors, they quickly dispersed. Their vessels are well-

equipped for crossing large water quickly and are often capable of staying out for several days.

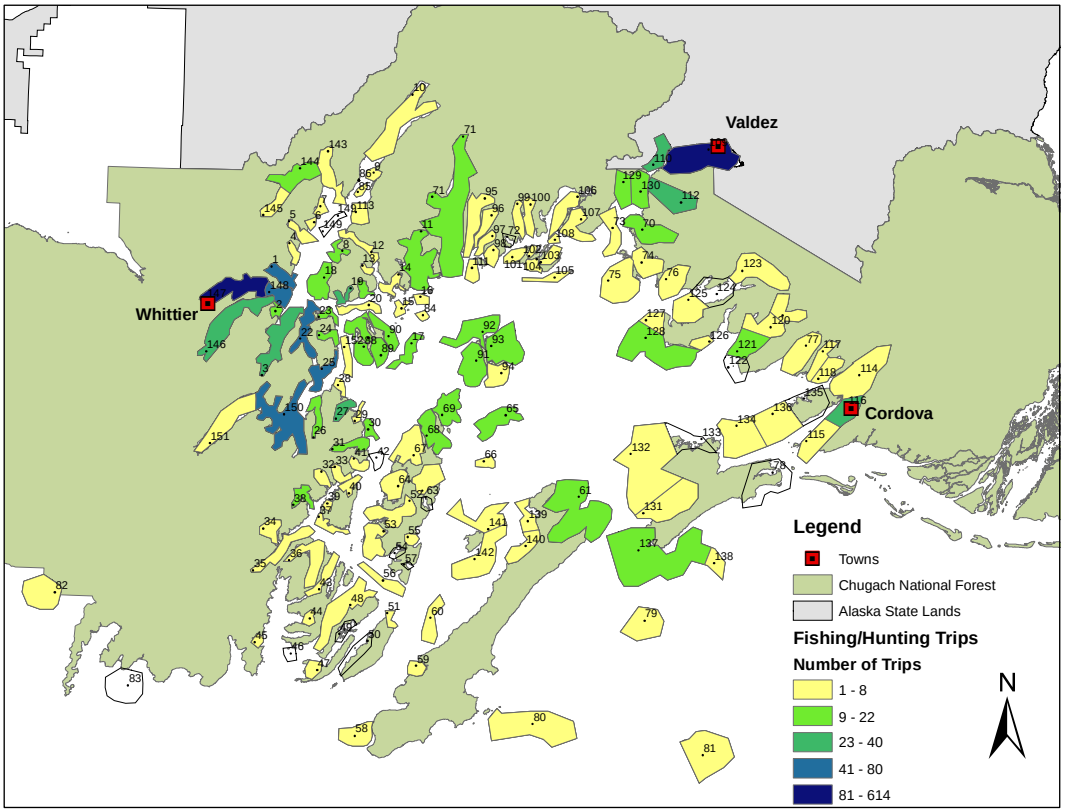


Figure 23: Number of trips taken by Fisher/Hunter subgroup

Fishers/Hunters represent the largest proportion of the sample. We made no attempt to differentiate fishers from hunters, and it is possible that both fishing and hunting took place in a single trip. Subsequent sections will examine the locations of each of these activities within the Sound. However, fishing trips were thought to be mostly comprised of single day trips while hunting trips often spent multiple days in a remote area of the Sound. This study did address these differences; however it is important to acknowledge that the behavior and travel patterns could be different for each group.

Table 32 and 33 list the top ten VUAs for trips and stops, respectively, for the fisher/hunter group of the sample for the Sound over the entire season.

Fishers/hunters visited 89% of the defined VUAs. The top ten VUAs captured 50% of the trips and 61% of the stops associated with this user group. The greater dispersion of use by fishers and hunters is not surprising; this group primarily uses vessels that allow them to traverse the Sound quite rapidly.

The fishers/hunters originating in Whittier appeared to visit areas such as Pig Bay (VUA 1) to the north as well as traveling South through Culross Passage (VUA 22) to reach areas such as Port Nellie Juan (VUA 150). Both Blackstone (VUA 146) and Cochrane Bays (VUA 3) also received a high number of trips. Visitor Use Area 144, the middle portion of Harriman Fjord, stands out as receiving a higher number of trips than other areas in the local region.

Fishing and hunting use appears to be concentrated to areas closer to Valdez than the cruising population. Visitation to Shoupe Bay (VUA 110) and Jack Bay (VUA 112) occurred quite frequently; however, once outside of the Valdez Narrow use declined considerably. The area to the west of Goose Island (VUA 128) appears to be a popular area for this group.

The areas surrounding Cordova do not appear to receive as many trips as other areas in the Sound. However, it is important to remember that the amount of use in Cordova is considerably smaller than either Valdez or Whittier.

The fishing and hunting population was easily the largest portion of the sample and visited most of the various Visitor Use Areas within the Sound. The results indicate that areas on either side of Hinchinbrook Entrance were popular areas for fishing or hunting, i.e., Visitor Use Areas 61 and 137. These areas likely have a specific draw such as halibut fishing according to charter operators based in Valdez.

Table 32 Ranked use based on the number of trips for the Hunter/Fisher subgroup

Rank	VUA	Number of Trips	Percentage
1	147	274	20.19%
2	109	126	9.29%
3	22	51	3.76%
4	148	48	3.54%
5	25	45	3.32%
6	1	36	2.65%
7	27	29	2.14%
8	112	26	1.92%
9	150	26	1.92%
10	146	24	1.77%
11-100		2-22	0.15%-1.62%
101-136		1-2	0.07%-0.15%

Table 33 Ranked use based on the number of stops for the Hunter/Fisher subgroup

Rank	Visitor Use Area	# of Stops	Percentage
1	147	614	26.88%
2	109	331	14.49%
3	22	80	3.50%
4	150	79	3.46%
5	25	64	2.80%
6	148	60	2.63%
7	1	58	2.54%
8	116	40	1.75%
9	71	38	1.66%
10	146	38	1.66%
11-100		2-37	0.09%-1.62%
100-135		1-34	0.04%-1.49%

6.4.4 Spatial Dispersion of Activities Participated in During Trips in the Sound

This section describes the frequency and distribution of activities across the Sound. Participants were asked to provide information about the activities they participated in at each of the stops they identified in their map itineraries. Initially 21 categories of activities were created based on the given responses. Upon further examination, these 21 categories were consolidated into six groups—three water-based and three land-based activity groups. The water-based activity groups include (1) wildlife viewing, (2) pleasure boating, and (3) fishing. Wildlife viewing is defined

as those activities for which the purpose is viewing wildlife, including glassing for bear or viewing harbor seals. It is assumed that the majority of wildlife viewing occurred from a boat. Pleasure boating may be enhanced by the use of a secondary vessel to explore the coastline or a bay. Fishing is by definition a water-based activity. Popular species sought while fishing include salmon, halibut, rockfish and shrimp. Land-based activity groups include (4) hunting, (5) day use and (6) camping/cabin. Hunting is a land-based activity and includes species such as bear, deer and sheep. Day Use land activities are short in duration and include activities such as beach combing, picnicking and hiking. Camping/Cabin is a land-based activity in which someone spends the night on land in either a tent or a cabin.

The Chugach National Forest expressed interest in identifying areas where users access land. Table 34 lists the proportion of trips that participated in each activity type. Nearly 75% of the reported trips consisted of water-based activities, while 27% participated in land-based activities. It is not surprising that water-based activities dominate the Sound. Also, note that fishing is the most dominant activity. This section will focus on the specific locations of these six activity groups within the Sound. The specific point locations for these activities were used in order to provide the greatest detail.

Table 34: Number and percentage of trips which participated in each of the six activity groups.

Activity	# of Trips	Percentage
Wildlife Viewing (Water Based	274	22%
Pleasure Boating (Water Based)	23	2%
Fishing (Water Based)	624	50%
Hunting (Land Based)	23	2%
Day Use (Land Based)	185	15%
Camping/Cabin (Land Based)	132	10%

Figures 24 through 29 display the location of activities reported by the sample for wildlife viewing, pleasure boating, fishing, hunting, day use, and camping/cabin, respectively. When looking at these maps and the locations of the specific activities it is important to remember that there was an unequal distribution of use throughout the Sound. For that reason we should expect to observe a higher number of activities in those areas that received more use. Conversely, areas that received little use would be expected to have fewer activities associated with them.

Figure 24 displays the spatial distribution of wildlife viewing across the Sound for the sample. Wildlife viewing occurred throughout the Sound; however a majority of use appears to be concentrated in the western Sound. Areas such as the head of Blackwell Bay with tidewater glaciers were popular destinations for wildlife viewing. This activity appears to be primarily concentrated to bays and inlets. Section 7.1 of this paper discusses human use in proximity to known wildlife sites in greater detail. The impact recreation has on wildlife in the Sound is beyond the scope of this study. This issue should be assessed in future studies.

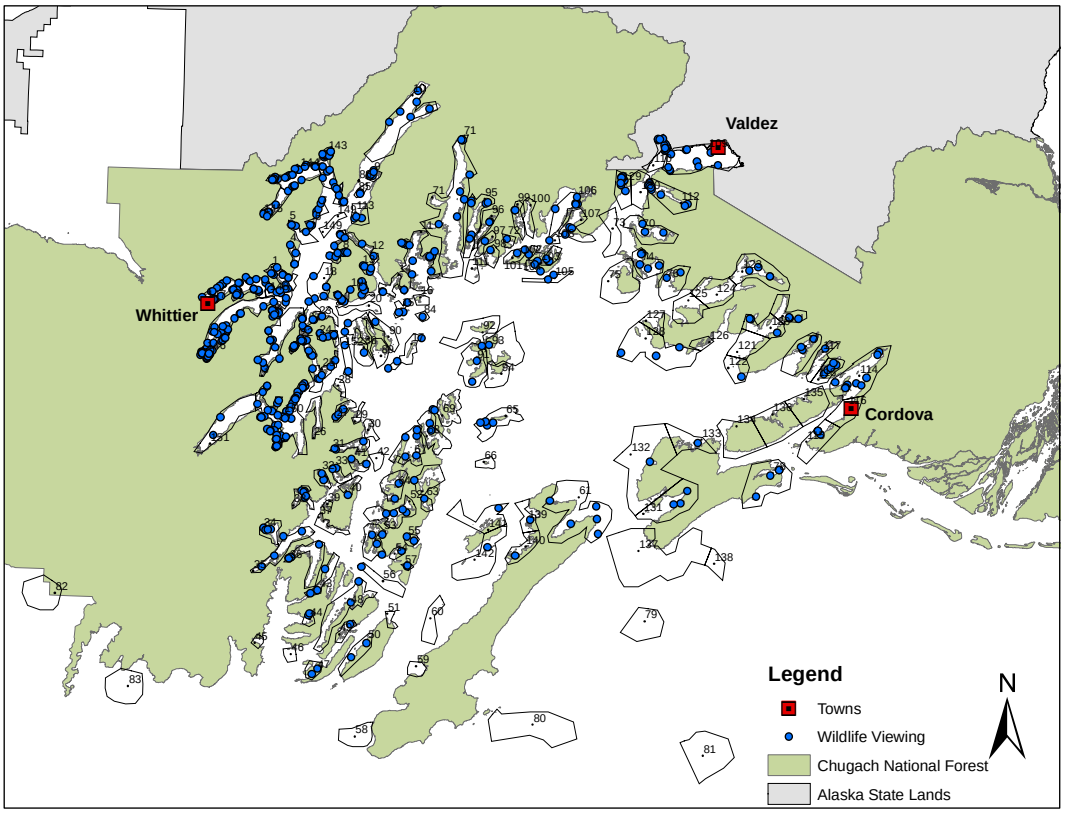


Figure 24: Location of wildlife viewing activities

Figure 25 displays the locations of pleasure boating activities. Pleasure boating also appears to have occurred in various inlets and bays throughout the Sound. This activity was quite limited overall with only about 2% of the trips participating. Even though our sample is quite small, the fact that such a small percentage of respondents participated in pleasure boating activities suggest that these are relatively rare occurrences. Also note that based on our sample, pleasure boating trips are isolated occurrences, i.e., there are only single occurrences for any given location. This activity likely has very little impact on both the land and the wildlife in the Sound.

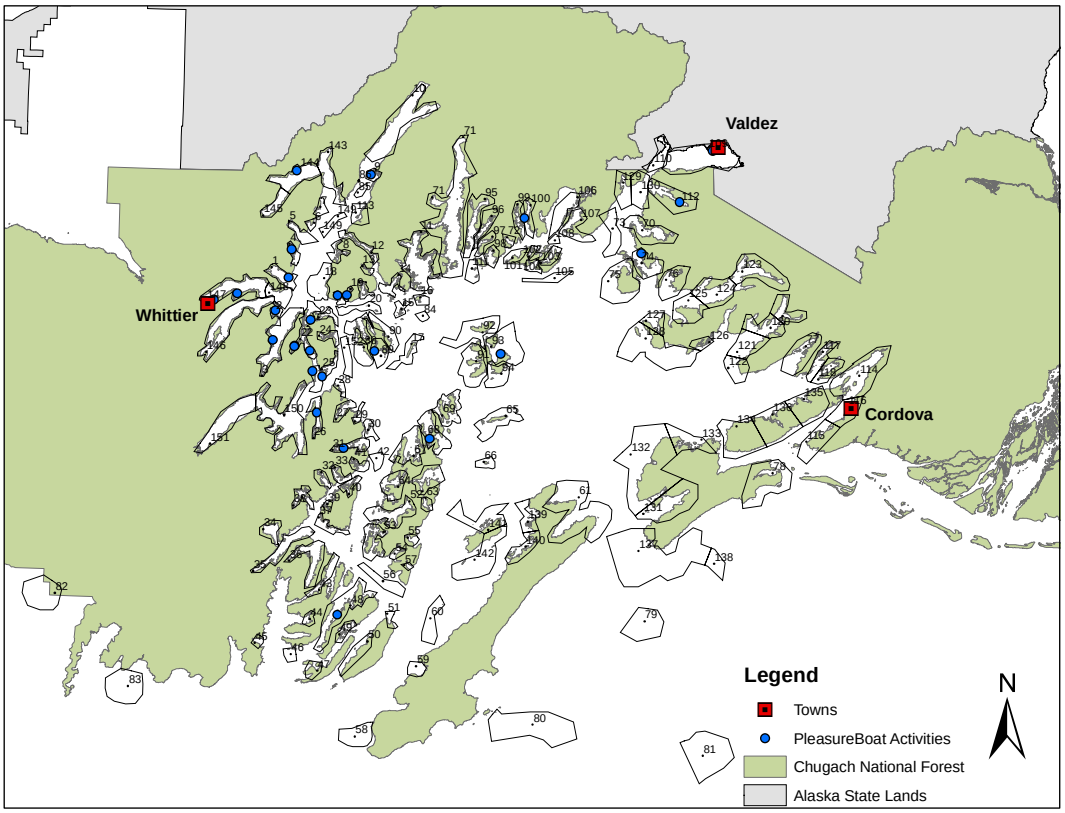


Figure 25: Location of pleasure boating activities

Figure 26 displays the location of fishing activities based on our sample. Approximately 50% of the trips participated in fishing activities. A majority of fishing appears to have taken place in the western Sound; however, the Port of Valdez and some of the adjacent areas received substantial use. Fishing generally occurred near land where the water may be calmer as opposed to open water further out in the Sound. Some fishing was observed outside the Sound past Montague Island. In general it was assumed that the reported instances were saltwater fishing, as illustrated in Appendix E where we see that only approximately 6% of respondents participated in freshwater fishing. Therefore fishing activities, as reported by our sample, would have minimal impact on the land.

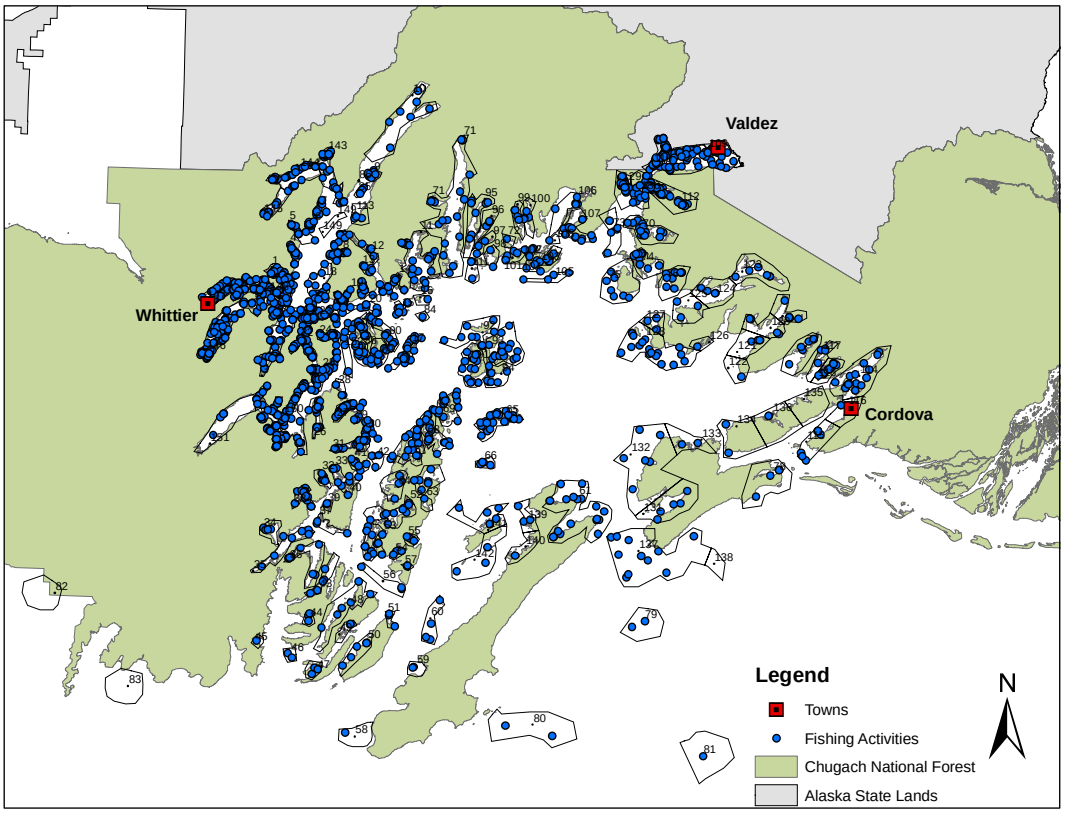


Figure 26: Location of fishing activities

Figure 27 displays the location of hunting activities in the Sound. Hunting only accounted for 2% of overall boating use in the Sound. Based on our sample, most of the hunting took place in the western Sound. However as stated before, reported activities are dependent on total use of the area, and since use levels in the western Sound were generally higher we would expect higher number of reported fishing activities in the western Sound. Hunting is the first of three land based activities our study addresses. Respondents were asked to indicate the location of where they accessed land; however they were not asked to provide any other information. As a result we are limited in our discussion on how hunters dispersed once they went ashore. Regardless, valuable information can be obtained by determining where hunting trips originated on land.

The survey crew noted that based on personal discussion with hunters many hunting trips were multiple-day trips. A comparison of figures 27 and 29, hunting and camping/cabin use respectively, illustrates that many of the hunting locations also had camping and cabin use associated with them. It is beyond the scope of this study to associate these two activities specifically; future studies however could address this relationship.

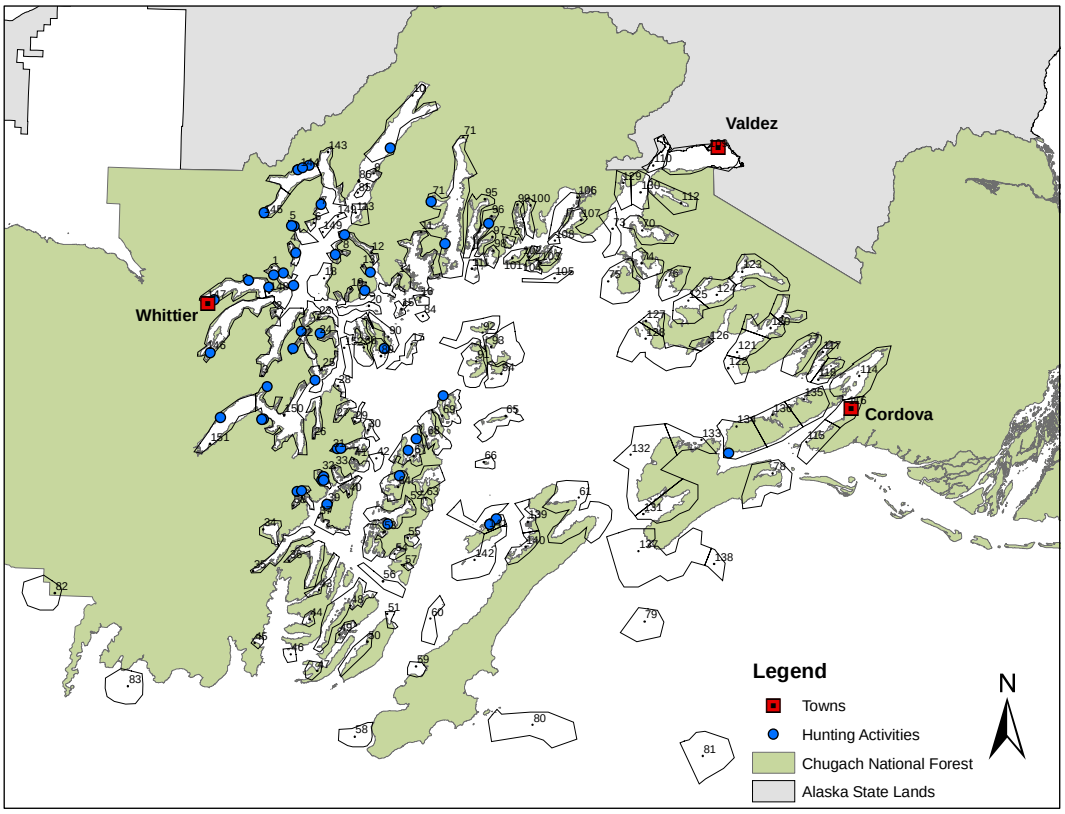


Figure 27: Location of hunting activities.

Figure 28 displays the location of day use activities, such as picnicking and beach combing. These activities appear to be concentrated in areas close to the harbors or in the western Sound. Those close to the harbors could be assumed to be the result of day trips while those further out, as in the western Sound, are part of multi–day trips. Based on our sample, 15% of the trips participated in this activity

type. The extent of the impacts caused to the land by these activities likely varies from group to group or individual to individual.

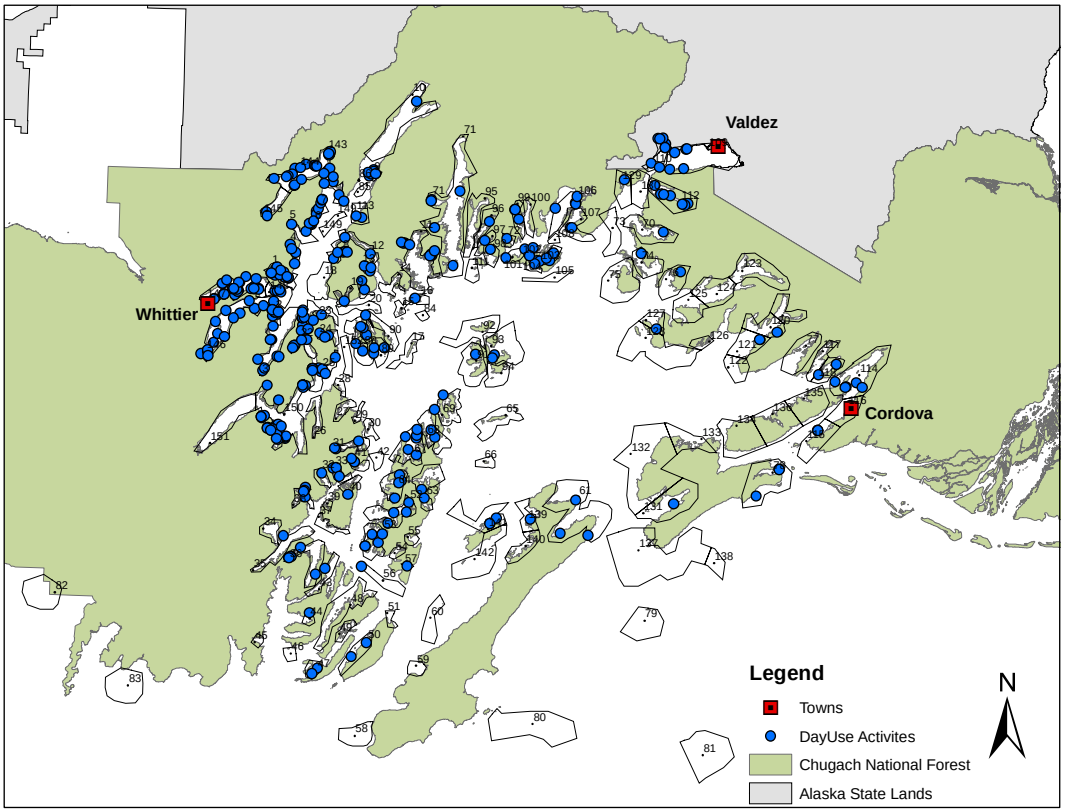


Figure 28: Location of day use activities.

Figure 29 displays the locations where respondents reported either camping or cabin use within the Sound. Based on our sample approximately 10% of the trips participated in this activity type. A majority of the camping and cabin use occurs in the western Sound where recreation has been managed more intensively in the past due to higher use levels. The USFS administers the rental of 15 cabins located throughout the Sound. Occupancy rates of cabins are quite high for a majority of the season, although the exact number varies from year to year. It is reasonably safe to assume that these cabins would be occupied, particularly during the core season. Besides USFS cabins there are also a handful of state-owned cabins located in the Sound as well as numerous private cabins. However, based on our sample the use of

private cabins appears to be relatively small (per comments provided by respondents in the map/itinerary portion of the survey). There are no designated camp site locations within the Sound. On USFS lands in the Sound visitors are free to camp wherever they wish. However, the steepness of the shoreline and tidal fluctuations limit access to certain locations within the Sound by limiting safe locations to dock a vessel.

The nature of camping or overnighting in a cabin allows visitors to explore the local area as they please. Because of this, the impacts to the surrounding land could be greater than areas without overnight amenities. On-site evaluations of these locations are needed in order to asses the severity of the impacts caused by humans.

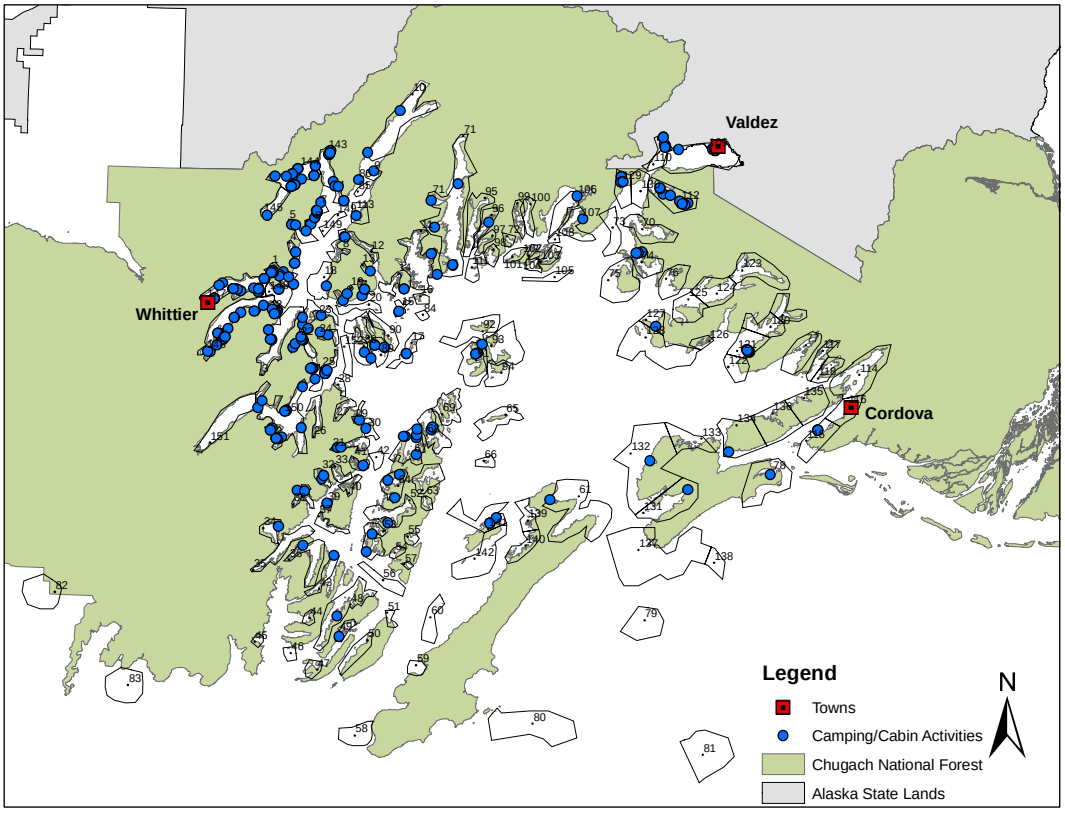


Figure 29: Location of camping or cabin activities

6.4.5 Section Summary

In chapter 4 we associated activities with vessel types. In this section we focused on determining the spatial locations and patterns of water- and land-based activities throughout the Sound. Although a majority of the activities visitors participated in were water-based, the ability to determine the locations where visitors access land will provide beneficial information to the land managers of the Chugach National Forest. The severity of the impacts to the Sound likely varies by location and group. Broad-scale patterns were observed, such as many activities occurring in the inlets and bays of the western Sound. Water based activities dominated with nearly 75% of trips reporting participating in such activities. Although land based activities were reported relatively infrequently, their locations and impact on the Sound are of greater interest to the Chugach National Forest. Future studies would be needed to determine the resource impacts of the land based activities to the lands of Prince William Sound.

6.4 Temporal Dispersal of Use

This section describes the temporal dispersion of use over the season in 2005 based on sample data. The season for recreating on Prince William Sound runs from early May until late September. For this analysis, the season is broken down into the early season (May 1- June 14), the core season (June 15- August 15), and the late season (August 16- September 30). Use was also broken down by month in order to determine the temporal dispersion of use levels in greater detail. This discussion will focus on the use according to the three seasons, for which Figures 30 through 32 graphically illustrate the dispersion of trips. When looking at the figures it should be noted that the three seasons have different number of days in them and more importantly, the number of trips during each of the seasons varied; thus the color pattern is intended to represent the gradient among high and low use areas, not the absolute number of trips. Table 35 then illustrates in greater detail the different use levels between the three seasons, both in number of trips and number of stops.

6.4.1 Temporal Dispersal of Use by the Three Seasons

Early Season Trips:

During the first part of the season most areas of the Sound were visited by at least one recreation trip. The areas around Whittier received the majority of use. By looking at the ranges in the number of trips, however, we can observe that many of those areas received 17 or fewer trips during this time period. The areas surrounding Whittier and Valdez witnessed a majority of trips. Approximately 23% of the use occurred during the early season.

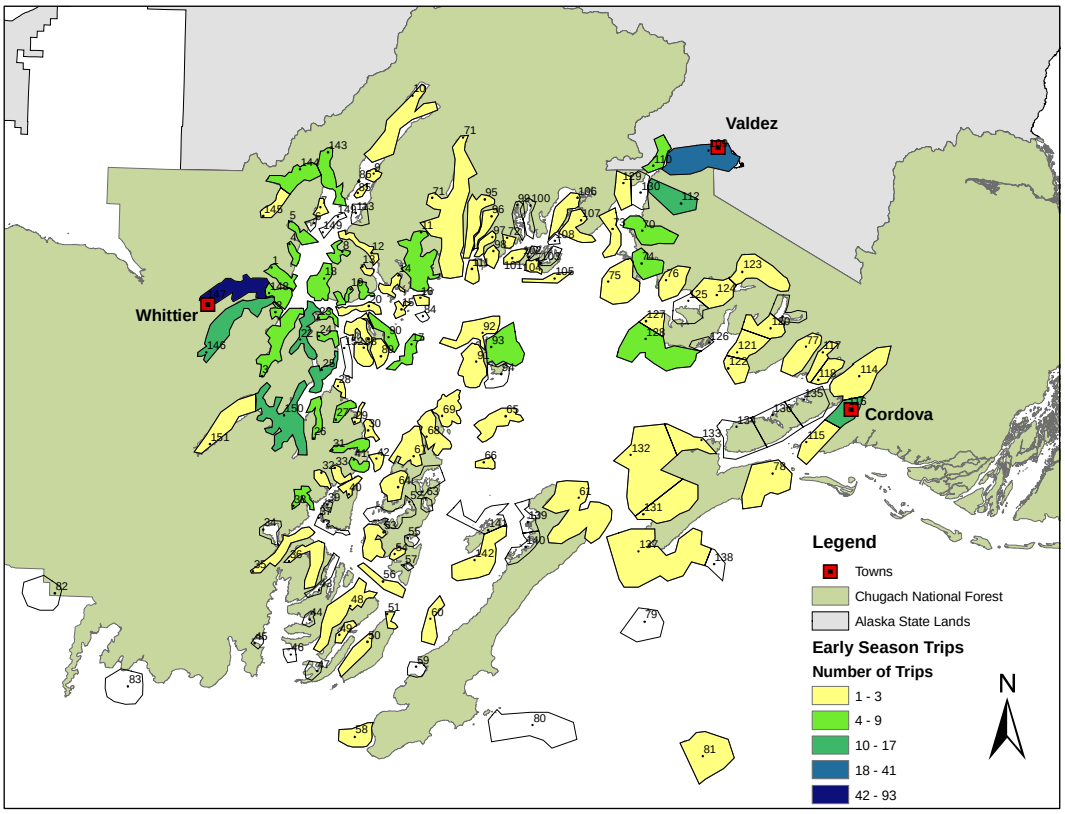


Figure 30: Total number of trips to each VUA during the early season

Core Season Trips:

A similar pattern of use seems to occur during the core season where the western Sound and Whittier receive a majority of the trips. Approximately 65% of the summer recreation in the Sound occurs during this season. The dispersion of the visitors is also greater in that 145 out of the 152 Visitor Use Areas were visited by at least one trip.

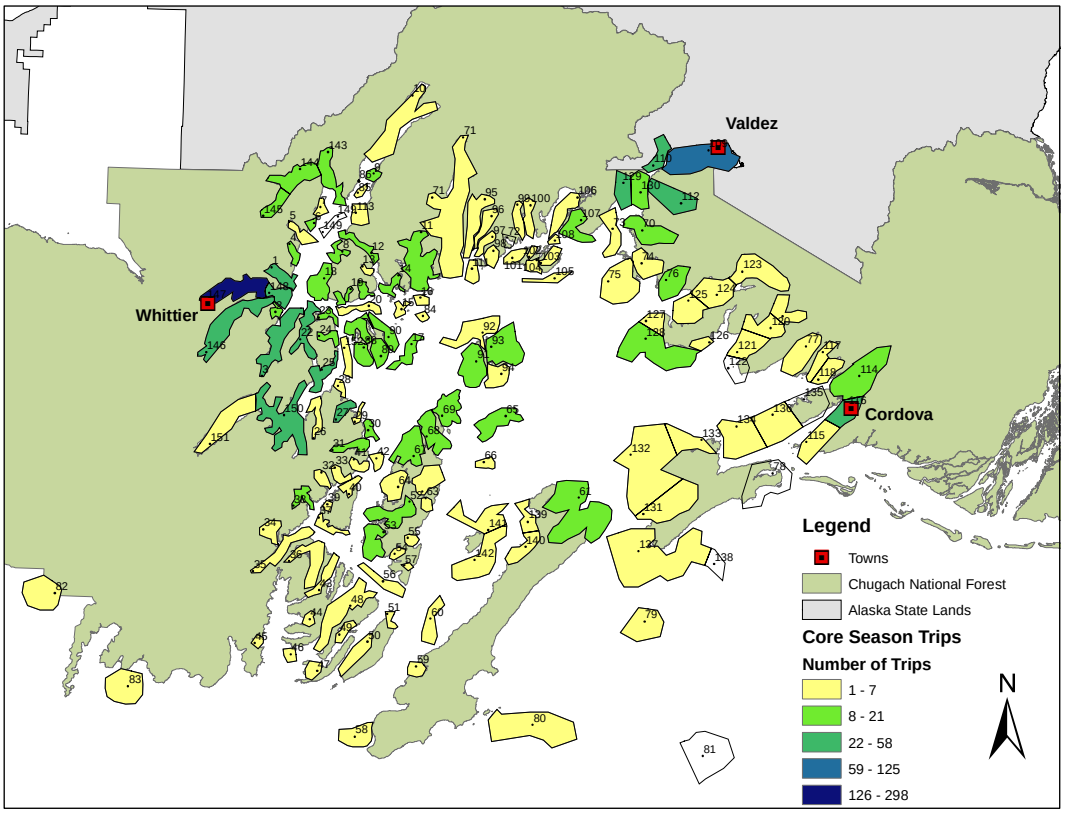


Figure 31: Total number of trips to each VUA during the core season.

Late Season Trips:

Use during the last part of the season drops considerably. The "high-use" areas are only receiving up to 41 trips, considerably lower when compared to the previous seasons. The dispersion of use appears to be limited as well; only 53 Visitor Use Areas were visited. Approximately 10% of the summer's use occurred during the late season—the lowest of all three seasons.

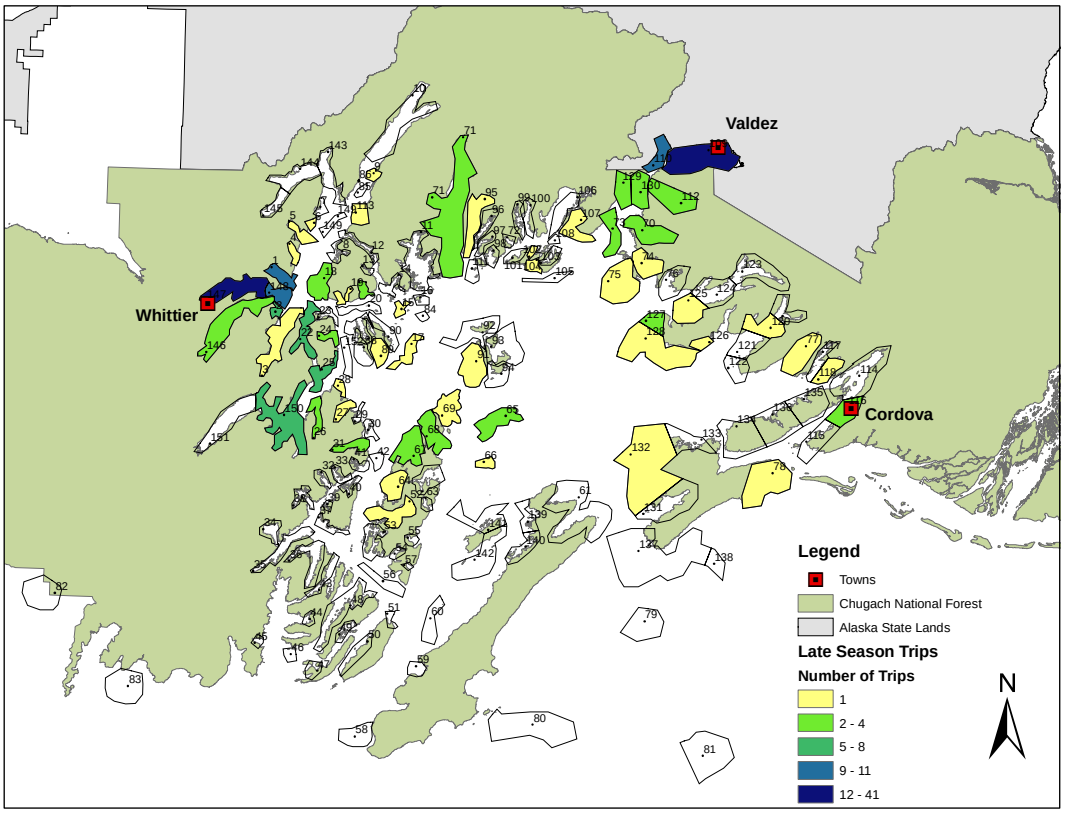


Figure 32: Total number of trips to each VUA during the late season.

Table 35: Temporal dispersion of visitor use based on sampled data and number of VUAs visited per time period.

Season/Month	# of Trips	# of Stops	# of VUA's Visited n= 152	Percent of use (# of trips)
Entire Season	729	3989	149*	100%
May1- June 14	166	849	111	23%
June 15- Aug.15	475	2662	145	65%
Aug.16- Sep. 15	73	352	53	10%
May	109	564	84	15%
June	145	873	125	20%
July	227	1277	128	31%
August	193	983	97	26%
September	37	175	31	5%

* Three use areas were not visited.

Table 35 shows that a majority of the use (65%), measured in number of trips, did occur during what managers coined as the "Core Use Season" (June 15th through

August 15th). Use levels in the shoulder seasons dropped off considerably to 23% and lower. When looking at use on a monthly basis, we can determine that July appears to experience the most use with 31% of the use occurring then. September saw the lowest use levels, with only 5% of the trips. To get a sense of the dispersal, the number of Visitor Use Areas visited during each month was calculated. The assumption that as use increases the number of Visitor Use Areas visited would also increase was tested. We can see that indeed the core season, as well as the month of July, witnessed a greater number of VUAs being visited.

6.4.2 Change in number of trips per VUA across the season.

This section examines the change in the number of trips to the top Visitor Use Areas in the Sound. The top ten VUAs for each of the five months were compared to determine how visitation changed over the season. Table 36 lists the top VUAs for each month and the associated number of trips. We then culled Table 36 to those ten VUAs that were consistently in the top ten. Figure 33 displays the most visited VUAs over the season (VUA 147 and 109 were suppressed since they are associated with the access points of Whittier and Valdez, respectively).

Table 36: Top ten VUA each month with number of trips in parenthesis

Rank	May	June	July	August	September
1	147 (147)	147 (227)	147 (352)	147 (273)	147 (60)
2	109 (64)	109 (83)	109 (139)	109 (183)	109 (45)
3	150 (50)	150 (35)	22 (41)	22 (31)	22 (9)
4	116 (23)	22 (30)	25 (40)	25 (30)	1 (8)
5	146 (23)	116 (24)	146 (35)	148 (29)	110 (8)
6	22 (15)	146 (20)	150 (31)	1 (28)	148 (7)
7	3 (11)	110 (15)	112 (30)	150 (25)	2 (5)
8	144 (11)	114 (15)	1 (24)	110 (20)	25 (4)
9	143 (10)	61 (14)	27 (23)	2 (18)	68 (3)
10	1 (9)	67 (13)	148 (22)	146 (18)	26 (2)

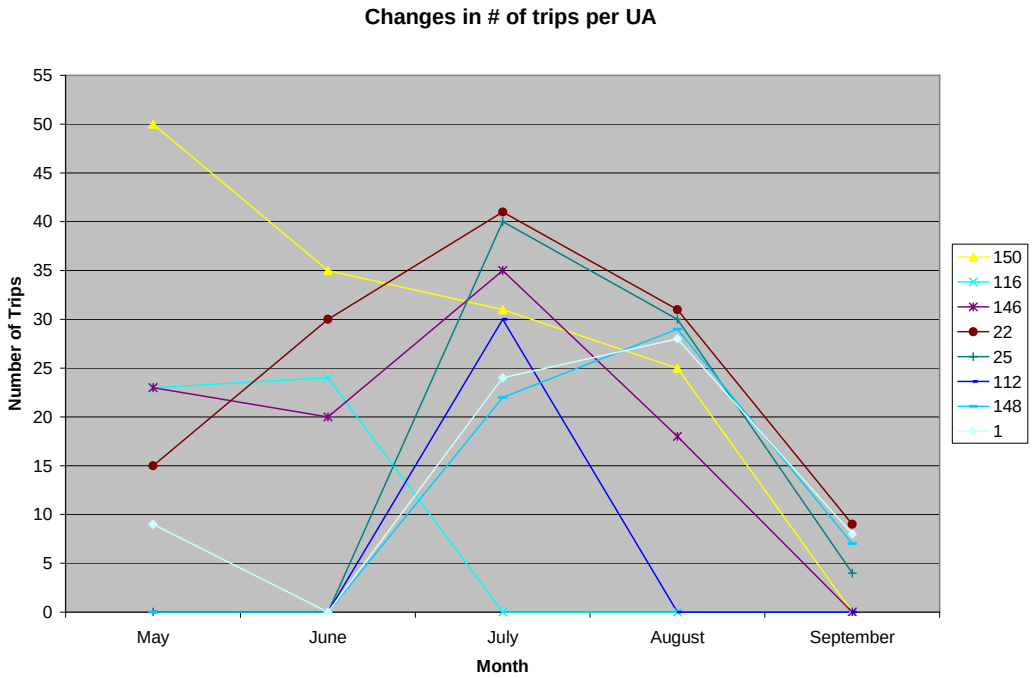


Figure 33: Changes in number of trips to the top eight Visitor Use Areas

Peak use occurs in either July or August for most of the VUAs represented here, which coincides with peak use in the Sound. VUA150, part of Port Nellie Juan outside of Whittier, however, has a very different use pattern. As the season progresses, fewer trips frequent the area, which may indicate that there is some draw to the area during the early part of the season. It should be noted that those VUAs where use drops to zero on the graph does not mean there were no trips to that particular VUA; instead they no longer were part of the top ten most frequently visited VUAs during that month.

The sample and return rates for each month would be expected to play a role in the reported number of trips to each Use Area. That is, the reported trips would be a function of how many surveys were distributed and returned each month. Although return rates were somewhat constant throughout the season, the number of surveys distributed varied considerably by month. Please see chapter 4 for a detailed discussion of survey and return rates.

6.5 Summary

This chapter began with a discussion about the creation of the spatial database and the various methods used during the analysis of these data. Spatial distribution was examined by number of stops and by number of trips occurring in each Visitor Use Area throughout the Sound. Furthermore, spatial distribution was segmented by harbor and by user group in order to facilitate analysis across each. Results indicate that the dispersal of use varied throughout the Sound. Based on our sample, approximately 66% of the use in the Sound originated from Whittier. As a result, use levels were considerably higher in the western Sound as compared to the eastern Sound. In this chapter we expanded the results presented in Chapter 4, where we associated activities with vessel types, and determined the spatial locations and patterns of water- and land-based activities throughout the Sound. We also discussed Suring et al's (2004) model, which identified 28 variables possibly influencing the spatial distribution of recreationists throughout the Sound. Based on our sample, broad-scale patterns were observed such as many activities occurring in the inlets and bays of the western Sound. Although a majority of the activities visitors participated in were water-based, we were particularly interested in identifying the locations where visitors access land. Most visitors were identified as members of fishing and hunting user group. Trip characteristics varied by user groups, particularly by the activities in which they participated. The ability to associate activities with user groups should provide guidance in the creation of a recreational monitoring plan for the Sound.

Temporal dispersion of use was also addressed in this chapter. Approximately 65% of the use occurred during the "core season" (June 15- August 15) use during both of the shoulder seasons was considerably less. Use levels at each of the Visitor Use Areas generally followed the change in use levels for the entire Sound, e.g. as use in the Sound increased the number of stops and trips to most VUAs also increased. These results provide beneficial information to the land managers of the Chugach National Forest and should aid in the development of a management plan addressing

visitor use in the Sound. Future studies would be needed to determine the resource impacts of the land based activities to the lands of Prince William Sound.

Chapter 7- Human Use Associated with Known Wildlife Sites In Prince William Sound

The *Exxon Valdez* oil tanker grounded on Bligh Reef on March 24th, 1989, spilling approximately 11 million gallons of Prudhoe Bay oil that altered the ecosystem of Prince William Sound in numerous ways. Nearly two decades later, the impacts of this ecological disaster are still evident and continue to be studied. As a result of a $900 million civil settlement with Exxon, the *Exxon Valdez* Oil Spill Trustee Council (EVOS) was established. Their goal is to oversee restoration of the ecosystem. They have identified a number of species that were negatively impacted by the spill. Monitoring the recovery of these species continues today. EVOS' annual reports categorize affected species into four groups; Recovered, Recovering, Not Recovered and Recovery Unknown. They note that the recovery of certain species is important to both the commercial fishing industry and residents who depend on these species for subsistence purposes (EVOS 2004). Our study focuses on the proximity of human use in relation to five species; bald eagle (*Haliaeetus leucocephalus*) nest sites, Black Oystercatcher (*Haematopus bachmani*) nest territories, harbor seal (*Phoca vitulina*) haul-out sites, Pigeon Guillemot (*Cepphus columba*) nest sites, and cutthroat trout (*Oncorhynchus clarki*) streams. This analysis at best is speculative as the inventory of nesting sites was undertaken in years prior to this study so the two data sets would be impossible to compare. However this analysis does provide a view of what interaction is possible and where further studies should focus to examine human/wildlife interactions.

Numerous other studies have examined various aspects of the impacts associated with the spill as well as how species are recovering. Day et al. (1997) found that "the *Exxon Valdez* oil spill had significant, negative impacts on habitat use by nearly half of the species of marine-oriented birds [they studied] in Prince William Sound…" They conclude that species whose use of habitats that were originally impacted show clear signs of habitat use 1-2.5 years after the spill. Although many species are recovering, some populations have not been so fortunate. Furthermore,

recreation may hinder the rate of species recovery in some cases and locations. The impacts recreation may have on wildlife will be discussed in greater detail in the discussions for each specific species. The goal of this portion of the study is to provide managers with information on the concentration of recreation in relation to habitat areas for these five different species.

As with previous analyses in this thesis, the maps provide spatial context and an overview of recreation use in the Sound. The data we collected provide a comparison between human use and known wildlife sites. Tables of the top ten wildlife sites are ranked by density of wildlife sites per acre. Stops per acre were calculated from the total number of stops occurring in a Visitor Use Area based on our sample for the entire season. Assuming our sample is representative of the spatial and temporal patterns of recreation use in the Sound, its relative distribution of recreation use should identify areas of potential conflict between human use and species recovery.

7.1 Bald Eagle Nest Sites:

Bald eagles were minimally influenced by the oil spill. Bowmant (1995) found that there was no difference in the survival rates between eagles that were radiotagged in oiled areas and those in non-oiled areas. They also predicted that bald eagle populations would return to pre-spill size by 1992. Since 1996 the EVOS has consistently listed the bald eagle as "Recovered", indicating that all recovery objectives have been met.

Figure 34 shows the distribution of bald eagle nest sites along with visitor stops data for our sample. The bald eagle nest sites appear to be concentrated in areas further away from the harbors, towards the middle and southern portions of the Sound. The tables show that areas such as Port Gravina (VUA 120) and Simpsons Bay (VUA 117) rank near the top of the list in density of nesting sites. Both of these VUAs are relatively close to Cordova, however, they receive a minimal number of stops. Eschamy Bay (VUA 31) in the western Sound has the 5th highest number of bald eagle

nest sites per acre as well as the highest number of stops associated with it. Steidl and Anthony (1996), as well as others, have studied the flush rates of bald eagles in Alaska during the summer recreation season. They state that although flush rates are variable and depend on a variety of factors, managers might consider establishing buffer zones around nest sites by determining "…the distance within which 95% of the eagles that are approached flush." (p.491). They found that for breeding and nonbreeding eagles in their study these distances were 200m and 220m respectively. According to our data, 122 VUAs had bald eagle nest sites associated with them. The number of bald eagle nest sites per acre decreases uniformly. A complete list of VUAs associated with bald eagle nest sites can be found in Appendix B.

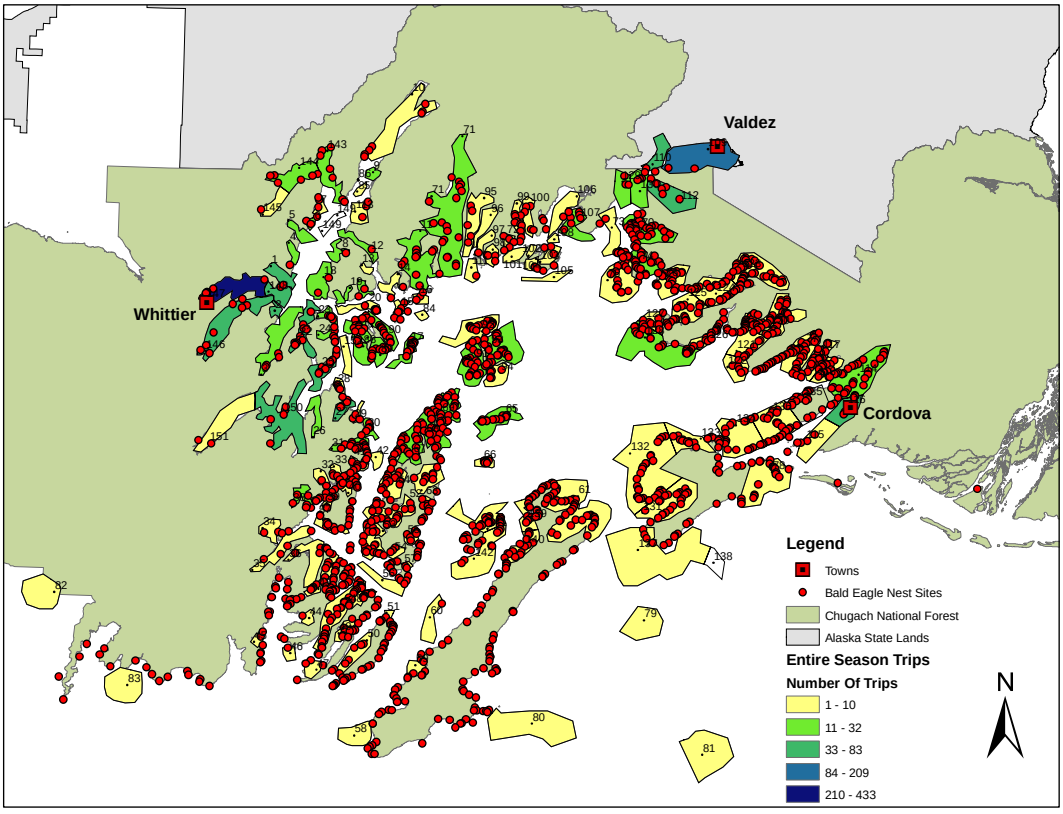


Figure 34: Overlay of bald eagle nest sites and visitor trips within VUAs

Table 37: Top ten VUAs based on the number of bald eagle nest sites per acre

Use Area	Bald Eagle Nest Sites Per Acre*	Stop Per Acre*
120	3.9	0.5
117	3.5	0.6
63	3.3	0.5
66	3.0	1.5
31	2.7	5.6
51	2.6	1.6
40	2.6	1.9
69	2.6	2.1
28	2.5	2.5
57	2.4	2.4

*Numbers were multiplied by 1,000 in order to increase resolution (e.g. 0.0039=3.9)

7.2 Black Oystercatcher Nest Sites:

In 1996, the condition of the black oystercatchers was listed as "Unknown" by the EVOS. Beginning in 1999 their status changed to "recovering" and in 2002 they were listed as a recovered species (EOVS, 2006). The black oystercatcher is a non-migratory species; what movement does occur happens during the spring and the fall. In general they remain close to their nesting areas, thus there is particular interest in determining the amount of human use associated with their nest sites. Warheit et al. (1984) state that human activities have both a direct and indirect impact on the black oystercatchers. They point out that black oystercatchers are "extremely sensitive to human disturbance" (p.101) and that human behavior has also restricted the breeding sites of the black oystercatchers to areas which are not accessible to humans. These same areas are often used by pinnipeds for hauling out and breeding. These interactions have resulted in crushed eggs and chicks as well as black oystercatchers abandoning their nests. These actions were found to lower the reproductive success of the black oystercatchers.

Figure 35 shows the location of the black oystercatcher nest sites in the Sound along with relative recreation use intensity. A high number of nest sites are located on the shores of Montague Island in the southern portion of the Sound. Based on our sample, the VUAs that are associated with this area received very little use throughout the season. Visitor Use Area 15, which encompasses a small group of islands

northwest of Perry Island, has the highest concentration of black oystercatcher nest sites. This VUA also has a relatively high number of stops associated with it during the season. Based on the table, VUA 144, Harriman Fjord, received the highest number of stops for a VUA in the top ten, but a relatively low density of nest sites. A total of 40 Visitor Use Areas encompassed black oystercatcher nest sites (please see Appendix B) and the number of nest sites per acre decreased rapidly.

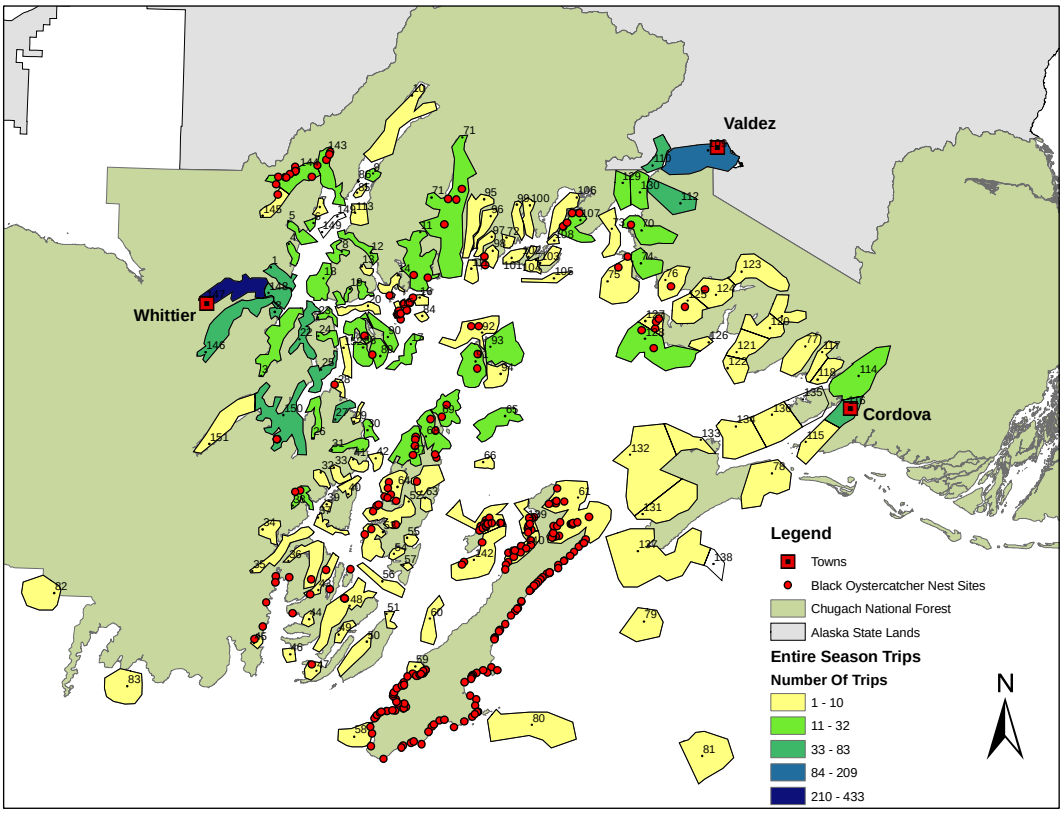


Figure 35: Overlay of black oystercatcher nest sites and visitor trips within VUAs .

Table 38: Top ten VUAs based on the number of black oystercatchers nests sites per acre.

Use Area	Black Oystercatcher Sites Per Acre*	Stop Per Acre*
15	2.5	3.4
59	1.7	0.6
139	1.7	0.5
140	1.6	0.3
141	1.2	0.5
144	0.9	5.0
107	0.7	2.3
127	0.6	1.3
61	0.5	0.5
28	0.5	2.5

*Numbers were multiplied by 1,000 in order to increase resolution (e.g. 0.0039=3.9)

7.3 Pigeon Guillemot nest sites:

The Pigeon guillemot was severely impacted by the *Exxon Valdez* Oil Spill. The EVOS has consistently listed the pigeon guillemot as "Not Recovering" (EVOS 2006). Furthermore, populations are continuing to decline as a result of a change in the diet found at this location, particularly around Naked Island which is located in the north central portion of PWS. The nestling growth rates on Naked Island were lower than those on Jackpot Island, which was not oiled by the spill (EVOS 1995). Suring et al. (2004) examined how recreation in the western portion of PWS relates to both pigeon guillemot nest sites and harbor seal haul-out sites. They state that "The potential for disturbance of pigeon guillemots extends throughout much of the recreational kayak and motorized boating season." (p13). They continue by identifying nest sites throughout the western Sound where they found recreation use to be concentrated.

Figure 36 indicates that many of the pigeon guillemot nest sites are located around Naked Island. A majority of the other sites are located to the south in the vicinity of Chenega and Port Bainbridge, which receive relatively few stops during the season. Naked Island however receives a considerable amount of use based on our sample. Three of the four VUAs (91, 92 and 93) associated with Naked Island rank in

the top ten in terms of number of nest sites associated with them. Visitor Use Areas 15 and 17 have relatively high numbers of stops associated with them, 4.7 and 3.4 respectively. VUA 15 appears to provide habitat for Pigeon guillemots and black oystercatchers as well as being a popular destination for visitors based on our sample. Visitor Use Area 17 encompasses Lone Island located west of Perry Island. Throughout the season there were 4.7 stops per acre in this VUA, but a relatively low density of nest sites. A total of 34 different VUA had Pigeon Guillemot nest sites in them. Overall numbers were low, ranging from 1.1 and dropping to 0.1 quickly. (Please refer to appendix B for a complete list of VUAs with pigeon guillemot nest sites.) Figure 36 also indicates that there are numerous nest sites in locations where, based on our sample, visitors did not stop, e.g. the western shoreline of Port Bainbridge, located in the southwestern portion of Prince William Sound. The areas identified in this study where recreation has a potential to disturb pigeon guillemots are very similar to those identified by Suring et al.

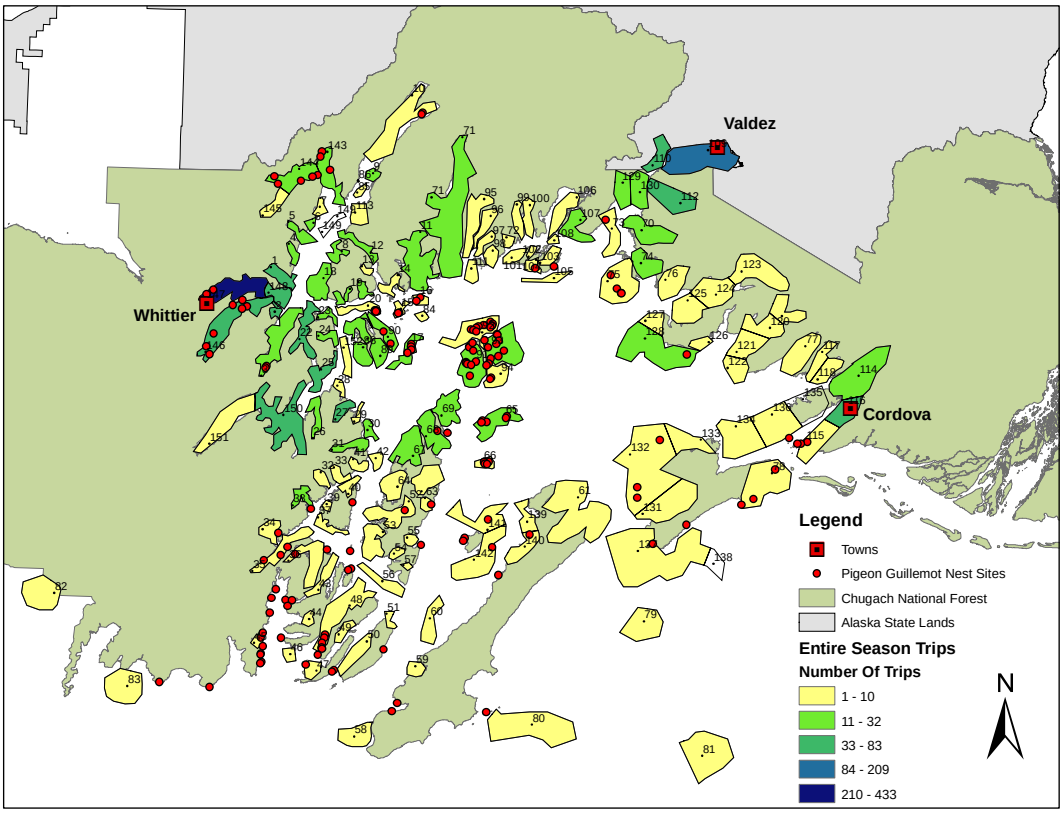


Figure 36: Overlay of pigeon guillemot nest sites and visitor trips within VUAs VUA.

Table 39: Top ten VUAs based on the number of pigeon guillemot nest sites per acre

Use Area	Pigeon Guillemot Sites Per Acre*	Stop Per Acre*
66	1.1	1.5
20	1.1	2.6
15	0.8	3.4
92	0.7	0.7
45	0.6	0.6
91	0.6	1.7
16	0.5	1.0
17	0.5	4.7
63	0.5	0.5
93	0.4	1.2

*Numbers were multiplied by 1,000 in order to increase resolution (e.g. 0.0039=3.9)

7.4 Cutthroat Streams:

The cutthroat trout is an anadromous fish species found primarily in the streams feeding the southern portion of Prince William Sound, as seen in Figure 38. There appears to be little research done on the population status of cutthroat trout in PWS other than the work by the *Exxon Valdez* Oil Spill Trustee Council. They list the cutthroat as "recovery unknown" due to limited data on the life history or extent of impact the oil spill had on the species.

Figure 37 shows that a majority of the cutthroat streams are located in the eastern Sound in the vicinity of Cordova. We can also see that recreation use at these areas is relatively low, most receiving less than 10 stops based on our sample. The Visitor Use Area with the greatest number of stream miles in it, VUA 126, only has 0.7 stops associated with it for the entire season. Visitor Use Area 118, the southern inlet of Simpson Bay received the most number of stops per acre; however, this area's recreation use is relatively low at 1.5 stops per acre. A total of 17 VUAs had cutthroat trout streams in them. Cutthroat trout are likely directly affected by fishing pressure; however, use appears to be low.

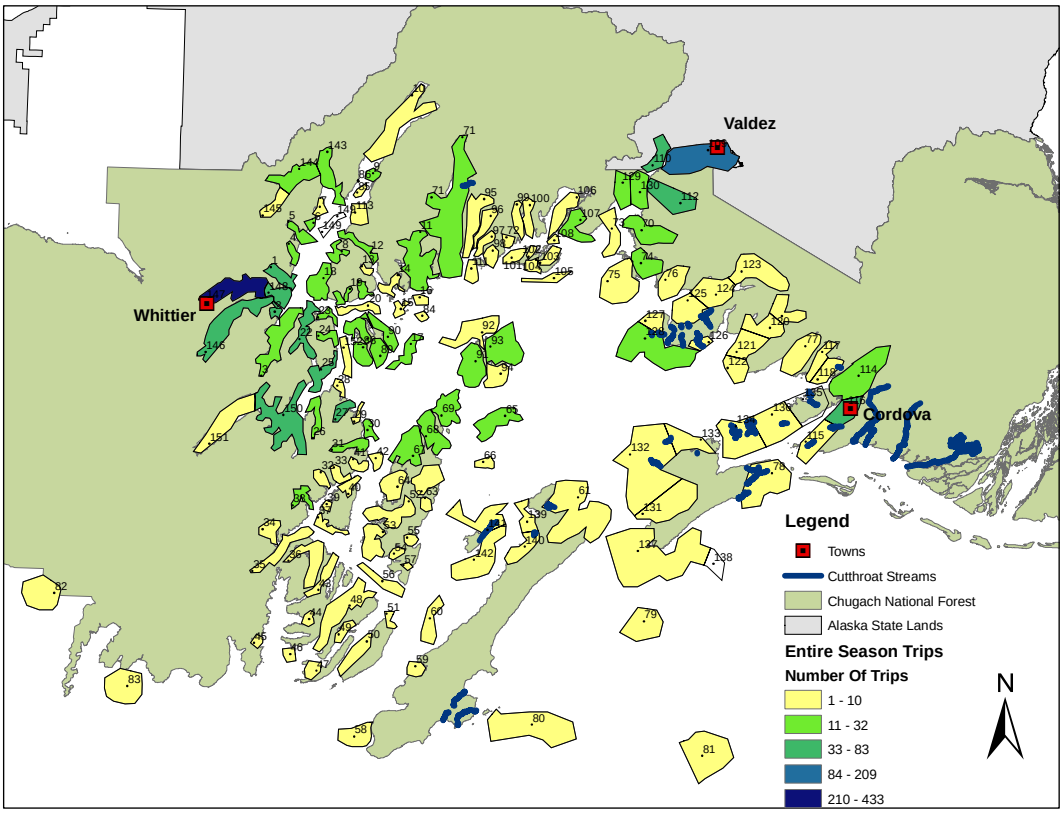


Figure 37: Overlay of cutthroat streams and visitor trips within VUAs

Table 40: Top ten VUAs based on the number of cutthroat streams per acre

Use Area	Cutthroat Trout Streams Per Acre*	Stops Per Acre*
126	2.3	0.7
134	1.9	0.1
78	1.0	0.2
140	0.9	0.3
141	0.8	0.5
115	0.7	0.6
118	0.6	1.5
136	0.4	0.1
127	0.4	1.3
132	0.3	0.1

*Numbers were multiplied by 1,000 in order to increase resolution (e.g. 0.0039=3.9)

7.5 Harbor Seal Haul-Out Sites:

The Harbor Seal is one of the most common marine mammal species in Prince William Sound. However, the exact number of harbor seals is unknown for the region. There is a documented decline of harbor seals since 1984, five years before the *Exxon Valdez* oil spill (Frost, 1999). This study found a statistically significant decline (4.6%) of harbor seals from 1990-1997 at their study sites. A study by VerHoef (2002) found a 3.3% decrease per year in the number of harbor seals from 1989 to 1999. Suring et al. (2004) report that "Although stress may increase in harbor seals as a result of boat-based disturbance, there is an indication that seals have a high level of tolerance for the presence of boats." (p. 13). They continue by stating that harbor seals may have become habituated to human presence. The *Exxon Valdez* Oil Spill Trustee Council listed the harbor seal as "Not Recovering" until 2006, when it was reclassified as "Recovered" (EVOS 2006).

Figure 38 shows that harbor seal haul-out sites appear to be uniformly distributed across the Sound. These areas also appear to be receiving limited recreation use. Table 41 illustrates that VUA 39, a bay on the western end of Chenega Island, has the highest density of harbor seal haul-out sites per acre at 0.9 and 1.8 stops per acre. The island to the north of the mouth of Emschamy Bay (VUA 30) received the highest number of stops. However, based on our sample, wildlife viewing was not notably concentrated in this area (please see section 6.3.1); rather, numerous fishing activities were reported in this VUA (please see section 6.3.3). A total of 49 different VUAs had harbor seal haul-out sites associated with them. The density of sites decreased steadily across the range, 0.9-0.1 sites per acre.

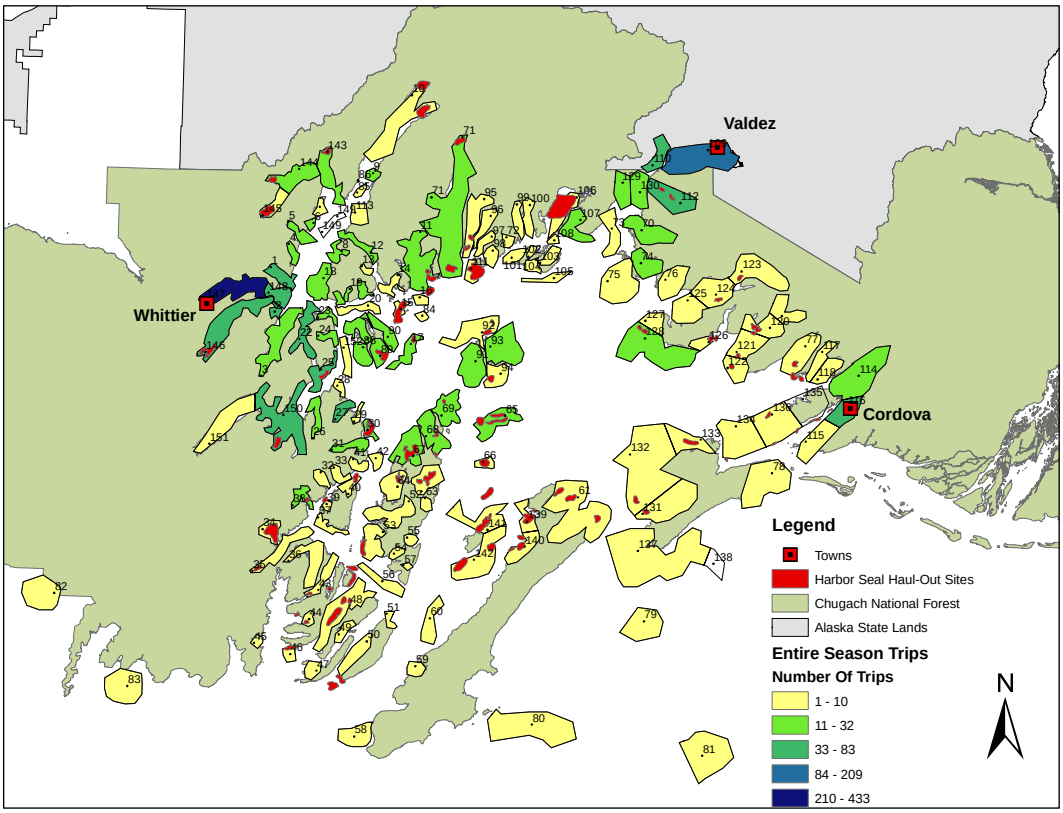


Figure 38: Overlay of harbor seal haul-out sites and visitor trips within VUAs .

Table 41: Top ten VUAs based on the number of harbor seal haul-out sites per acre

Use Area	Harbor Seals Sites Per Acre*	Stops Per Acre*
39	0.9	1.8
50	0.6	0.6
44	0.5	1.4
46	0.4	0.9
15	0.4	3.4
66	0.4	1.5
30	0.4	4.7
126	0.3	0.7
40	0.3	1.9
111	0.3	0.8

*Numbers were multiplied by 1,000 in order to increase resolution (e.g. 0.0039=3.9)

7.6 Summary:

The environmental impacts that were caused by the *Exxon Valdez* oil spill in 1989 are still felt throughout Prince William Sound. This section examined the amount of human use in proximity to five species that had in some manner been affected by the disaster. Overall the majority of the wildlife sites appear to be located in areas that are not receiving high recreation use. There are a few exceptions. In particular, Naked Island has numerous pigeon guillemot nest sites and attracts numerous visitors throughout the season. Other areas such as the Dutch Group (VUA 15) islands north of Perry Island are popular nest sites for both black oystercatchers and pigeon guillemots and receive relatively high recreation use.

Visitor Use Area 15 (Dutch Group) had the highest density for both black oystercatchers and pigeon guillemot nest sites on a per acre basis (2.5 and 0.8 respectively) and had a recreational visitor density of 3.4 stops per acre. Additionally VUAs such as Hanning Bay and Stockdale Harbor (VUA 59 and 139) both had 1.7 nest sites per acre and relatively low densities of recreation use (0.6 and 0.5 stops per acre respectively). It appears in this initial analysis that there is little correlation between the number of stops and the number of nest sites for both black oystercatchers and pigeon guillemots.

The highest density of bald eagle nest sites also had the lowest density of recreational visitor stops per acre. VUA 120 (Parshas Bay) had the highest density with 3.9 bald eagle nests per acre, which corresponded to the lowest density, 0.5 stops per acre, by recreational visitors. This suggests there could be a negative relationship between eagle nesting sites and visitor use, but further studies need to be done to quantify this relationship.

VUAs 39, 50, 44 (Dangerous Passage, Horseshoe Bay and Hogg Bay) had the highest densities of harbor seal haul out sites with 0.9, 0.6 and 0.5 sites per acre, respectively. There was no obvious relationship between haul out sites and density of recreational use.

Finally, VUAs 126, 134 and 78 (Hells Hole, Hawkins Island Cutoff and Boswell Bay) had the highest densities of cutthroat trout streams with 2.3, 1.9 and 1.0 streams per acre, respectively. There was no obvious relationship between stream density and density of recreational use.

As use levels in Prince William Sound are predicted to increase the amount of human disturbance at wildlife sites can be expected to increase as well. Managers will need to address these issues if they wish to work to protect wildlife in the Sound.

This portion of our study provides both land managers and wildlife biologist with an overview the levels of recreation use in proximity to wildlife sites. As discussed earlier in this section, this portion of the analysis is speculative because wildlife and recreation data were not colleted at the same time. In order to fully understand human use in relationship to known wildlife sites more data and further studies aimed specifically at addressing these interactions is needed. Our results may be used to identify priority sites for further investigation and monitoring of human/wildlife interactions.

Chapter 8 Conclusion

This thesis is the first in a series of studies comprising the Prince William Sound Human Use Study whose ultimate goal is the maintenance and protection of wilderness and ecological quality throughout the Sound. There were two main goals of this study. The first was to determine the types, distribution and seasonal variation of human recreational use in the Sound. The second was to determine the proximity of human use to previously identified wildlife sites in the Sound. Critical to the study was the use of GIS to evaluate mode of travel, destination, and frequency of visit, all of which are important in the study of human impacts on social and ecological systems. While the resulting dispersal patterns of users reported in this study illustrate the difficulty in managing visitor impacts, they also emphasize the need to collect additional spatial and temporal visitor data in order to evaluate visitor distributions and their impacts across the landscape.

This study adopted indicators identified by Cole (2004), who suggests primary factors influencing the intensity of impacts by humans on social and ecological systems, including the frequency, type and duration of use as well as the need to examine these factors across the entire season of use. Furthermore, these same data may be used to analyze the impact of human use on wildlife sites in the Sound. The results of this study are intended to provide baseline recreational use data and assist managers in developing management and monitoring plans to address human use throughout the Sound.

Management of the Sound, and its visitors, requires an understanding of the seasonal variability of use. Over 65% of the use occurred during the “core season”, 23% during the “early season” and only 10% during the “late season”. These results illustrate the concentrated nature of temporal use in the Sound. Although use levels peaked during the “core season” we found that the spatial distribution of use in specific areas changes across the seasons. In most cases the number of trips to Visitor Use Areas increased as overall use of the Sound increased. For example, we observed that VUAs such as Culross Passage (VUA 22) received the highest number of trips

during the month of July, part of the "core season". However, some areas such as Port Nelly Juan (VUA 150) experienced a decline in the number of trips as the season progressed. The ability to identify the spatial variability of use across the season is important for managing resources in the Sound.

Comprehensive visitor monitoring of the Sound would be prohibitively expensive and time-consuming on an ongoing basis. Since vessel type is observable and can be monitored at relatively low cost, associating visitor use patterns with vessel type has the potential to provide the basis for a method of estimating visitation and visitor use on an ongoing basis. Based on our sample, the most commonly used vessel type, at approximately 45% of total use, was the cabin cruiser. Users of this vessel type participated in a variety of activities during their trips. Conversely, only 3% of our sample used sailboats. Users of sailboats proportionally participated in activities different from cabin cruisers; e.g., more hiking and less fishing. As Suring et al. (2004) discussed, the Chugach National Forest is primarily concerned with visitor's use of the upland sites. In our study we distinguished between land- and water-based activities. Of the water-based activities, cabin cruisers and runabouts accounted for a majority of the fishing activities (salmon, halibut, rock, shrimping and other). Thus for example, if managers decide they would like to address fishing activities in the Sound then they should begin by concentrating their efforts on users with these vessel types. Most of the land-based activities were dominated by cabin cruisers, with the exception of staying at cabins and camping on land. A clear understanding of what vessel types participate in different activities combined with information on the number of each of the vessels types that are used in the Sound should allow managers to address issues pertaining to the types and intensities of activities in the Sound.

Section 6.4.4 of this thesis detailed the locations of where users participated in various activities throughout the Sound. Broad-scale patterns were observed. A majority of the activities were observed to occur in the inlets and bays of the western Sound, which also had the highest use based on our sample. Nearly 75% of trips reported participating in water-based activities. Although land-based activities were

reported relatively infrequently, their locations and impact on the Sound are important to the Chugach National Forest. This study was able to identify the specific location and frequency of where visitors accessed land throughout the Sound. On-site examination of these areas should be considered in order to determine the extent of visitor impacts on the land. Furthermore, as discussed in chapter 2, if biophysical impacts exceed the standards set by the management plan, consideration should be given to limiting use at areas that are negatively impacted.

Analysis of the potential interactions between humans and wildlife directly relates to the mission of the recovery of the Sound from the *Exxon Valdez* Oil Spill. Five species were analyzed (bald eagles, black oystercatchers, harbor seals, cutthroat trout and pigeon guillemot) to determine the interaction of recreational activities on known nesting sites of these species. This study identified areas of the Sound where human presence may impact wildlife, although there are concerns regarding the quality of the wildlife data. Managers could concentrate efforts to of mitigate visitor impacts on wildlife in these areas. A simple and relatively inexpensive method employed by many managing agencies is to provide educational information pertaining to impacts caused to wildlife by visitors. The goal of such information is to change visitors' behavior and reduce the impacts they may have on wildlife, especially during periods of time when wildlife are particularly sensitive and susceptible to human disturbance. In addition to providing educational information, efforts may be needed to redirect use away from nesting or haul-out sites. As Suring et al. (2004) discussed, attributes in the Sound, such as campsites, affect the distribution of kayakers and may need to be closed or restricted during times when wildlife are sensitive to disturbance. Similar to the recommendations listed above, consideration should be give to closing or otherwise discouraging use in the vicinity of sensitive wildlife areas. Further studies focusing on this issue specifically are needed in order to give wildlife biologist and land managers adequate information for evaluating specific management actions; i.e., if wildlife areas are being negatively impacted by visitor presence and use. This study has identified possible areas for further research.

This study provides critical, baseline information on the current recreational threats to the ecological integrity of the Sound. The next step is to develop a framework, at an appropriate scale, to manage the future growth of recreation/visitor use in the Sound to provide for the ultimate protection of the resources and wildlife that live within its bounds. As the number of visitors to the Sound increases, as expected, there is also a concern about visitor crowding. The scale of our data did not allow us to evaluate visitor crowding on a per trip or per user basis. However, we were able to use the data to illustrate general trends in visitor use and identify areas that may be prone to visitor crowding. Visitor Use Areas such as Passage Canal (VUA 147) and Port Valdez (VUA 109) had the highest concentration of both visitor stops and number of trips. This is expected since these areas contain the main access points to the Sound, Whittier and Valdez. Culross Passage (VUA 22) appears to be the preferred travel route for visitors from Whittier wishing to access the southwestern portion of the Sound. Based on our sample, 85 trips passed through this area, accounting for 3.55% of all trips. Blackwell Bay (VUA 146), located to the south of Passage Canal (VUA 147), also attracted a relatively large number of visitors. Based on our sample, 61 trips, or 2.55% of the total trips, entered this bay. With the predicted increase in recreation use of the Sound, managers should be aware of where visitors are likely to experience the highest number of encounters, feel crowded, and potentially alter their behavior in response to perceived crowding (e.g., changing the timing , location or types of activities participated in).. While this study did not evaluate visitor crowding specifically, it does identify areas that should be the focus of future studies aimed at addressing the issue of visitor crowding.

Changes in access conditions such as the opening of the Whittier Tunnel and the implementation of a high-speed ferry are expected to impact recreation in a number of ways. Although not specifically addressed in this study, it is reasonable to assume, based on the different characteristics of each of the harbors, that they have a unique type of user associated with each of them (e.g., Cordova is primarily a fishing harbor). With a high-speed ferry allowing users to base their recreation trips from any

of the three harbors, the use from each of the harbors may change. For example, although not a large portion of our sample, the only four respondents listing jet skis as their primary vessel originated their trip in Whittier. As users shift to different harbors, a change in vessel types and activities associated with each of the harbors will likely change. Based on our sample, Cordova witnessed very little sea kayak use. Since sea kayak users represented nearly 45% of the visitors who camped on land, an increase of these users in the area surrounding Cordova would result in greater numbers of visitors accessing land in that area.

The opening of the Whittier tunnel increased visitors' ability to transport their vessel to the harbor in Whittier. In the first years of operation the tunnel experienced a dramatic increase in use. It is unclear exactly how the opening of the tunnel will affect use-numbers of the Sound; however, with half of the state's population gaining access to Whittier, we expect use-numbers to continue to increase or at least maintain current levels. Although mooring spaces in Whittier are limited, visitors have the ability to launch their vessels using the boat ramp. Approximately one percent of the respondents indicated that they would relocate their vessel to a different harbor if mooring were available. Combined, these changes in access to and across the Sound have the ability to increase and alter the dispersal patterns of recreation use of the Sound.

This thesis provides baseline data on the recreation use in Prince William Sound Alaska. The types, distribution and seasonal variations of human use in the Sound were examined. The results presented here are intended to provide guidance for future studies addressing these issues in greater detail. Furthermore, this study calls for the development of a framework, at an appropriate scale, to manage the future growth of recreation/visitor use in the Sound, as well as to provide protection to the resources and wildlife within its bounds.

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APPENDIX

Appendix A: Number of trips and stops to each Visitor Use Area for the entire season, per harbor, per usergroup.

Number of trips per Visitor Use Area for the entire season

Visitor Use Area	Trips Per VUA	% Trips per VUA
147	481	20.12%
109	212	8.87%
22	85	3.55%
25	64	2.68%
146	61	2.55%
148	60	2.51%
150	55	2.30%
1	52	2.17%
112	45	1.88%
116	45	1.88%
110	43	1.80%
27	41	1.71%
2	39	1.63%
3	35	1.46%
129	32	1.34%
19	31	1.30%
17	28	1.17%
143	27	1.13%
31	24	1.00%
18	23	0.96%
24	22	0.92%
144	22	0.92%
65	21	0.88%
88	20	0.84%
128	19	0.79%
8	18	0.75%
11	18	0.75%
67	16	0.67%
70	16	0.67%
87	16	0.67%
130	16	0.67%
23	15	0.63%
68	15	0.63%
90	15	0.63%
91	15	0.63%
114	15	0.63%
6	14	0.59%
9	14	0.59%
12	14	0.59%

Visitor Use Area	Trips Per VUA	% Trips per VUA
21	14	0.59%
38	14	0.59%
69	14	0.59%
93	14	0.59%
107	14	0.59%
4	13	0.54%
30	13	0.54%
71	12	0.50%
74	12	0.50%
5	11	0.46%
26	11	0.46%
53	11	0.46%
61	11	0.46%
89	11	0.46%
7	10	0.42%
20	10	0.42%
145	10	0.42%
14	9	0.38%
36	9	0.38%
41	9	0.38%
52	9	0.38%
76	9	0.38%
15	8	0.33%
73	8	0.33%
118	8	0.33%
10	7	0.29%
13	7	0.29%
35	7	0.29%
48	7	0.29%
62	7	0.29%
92	7	0.29%
94	7	0.29%
95	7	0.29%
119	7	0.29%
131	7	0.29%
137	7	0.29%
96	6	0.25%
104	6	0.25%
115	6	0.25%

Visitor Use Area	Trips Per VUA	% Trips per VUA
123	6	0.25%
127	6	0.25%
29	5	0.21%
32	5	0.21%
33	5	0.21%
40	5	0.21%
47	5	0.21%
55	5	0.21%
64	5	0.21%
75	5	0.21%
77	5	0.21%
106	5	0.21%
113	5	0.21%
151	5	0.21%
28	4	0.17%
34	4	0.17%
43	4	0.17%
49	4	0.17%
66	4	0.17%
99	4	0.17%
100	4	0.17%
101	4	0.17%
102	4	0.17%
105	4	0.17%
117	4	0.17%
120	4	0.17%
125	4	0.17%
132	4	0.17%
141	4	0.17%
37	3	0.13%
42	3	0.13%
44	3	0.13%
54	3	0.13%
56	3	0.13%
60	3	0.13%
85	3	0.13%
97	3	0.13%
103	3	0.13%
124	3	0.13%
139	3	0.13%
142	3	0.13%
16	2	0.08%
39	2	0.08%
50	2	0.08%

Visitor Use Area	Trips Per VUA	% Trips per VUA
51	2	0.08%
57	2	0.08%
58	2	0.08%
59	2	0.08%
78	2	0.08%
79	2	0.08%
80	2	0.08%
98	2	0.08%
108	2	0.08%
111	2	0.08%
121	2	0.08%
126	2	0.08%
133	2	0.08%
134	2	0.08%
136	2	0.08%
140	2	0.08%
152	2	0.08%
45	1	0.04%
46	1	0.04%
63	1	0.04%
72	1	0.04%
81	1	0.04%
82	1	0.04%
83	1	0.04%
84	1	0.04%
86	1	0.04%
122	1	0.04%

Number of stops per Visitor Use Area for the entire season.

Visitor Use Area	Stops per VUA	% Stops Per VUA
147	1097	27.50%
109	516	12.94%
150	151	3.79%
22	130	3.26%
146	105	2.63%
25	94	2.36%
1	80	2.01%
116	79	1.98%
148	72	1.80%
112	61	1.53%
110	60	1.50%
144	57	1.43%
3	55	1.38%
27	51	1.28%
2	47	1.18%
143	47	1.18%
129	39	0.98%
19	35	0.88%
17	29	0.73%
8	27	0.68%
31	27	0.68%
11	26	0.65%
71	26	0.65%
114	26	0.65%
65	24	0.60%
18	23	0.58%
24	23	0.58%
67	23	0.58%
68	23	0.58%
91	23	0.58%
87	22	0.55%
88	22	0.55%
130	22	0.55%
61	21	0.53%
69	21	0.53%
128	21	0.53%
93	20	0.50%
107	20	0.50%
70	19	0.48%

Visitor Use Area	Stops per VUA	% Stops Per VUA
7	18	0.45%
38	18	0.45%
53	17	0.43%
6	16	0.40%
23	16	0.40%
76	16	0.40%
89	16	0.40%
9	15	0.38%
21	15	0.38%
26	15	0.38%
74	15	0.38%
90	15	0.38%
4	14	0.35%
12	14	0.35%
5	13	0.33%
14	13	0.33%
30	13	0.33%
20	12	0.30%
36	12	0.30%
52	11	0.28%
121	11	0.28%
137	11	0.28%
41	10	0.25%
92	10	0.25%
118	10	0.25%
145	10	0.25%
10	9	0.23%
35	9	0.23%
73	9	0.23%
95	9	0.23%
15	8	0.20%
48	8	0.20%
62	8	0.20%
94	8	0.20%
13	7	0.18%
33	7	0.18%
75	7	0.18%
77	7	0.18%
103	7	0.18%

Visitor Use Area	Stops per VUA	% Stops Per VUA
106	7	0.18%
115	7	0.18%
119	7	0.18%
127	7	0.18%
29	6	0.15%
32	6	0.15%
40	6	0.15%
43	6	0.15%
55	6	0.15%
96	6	0.15%
101	6	0.15%
104	6	0.15%
123	6	0.15%
131	6	0.15%
132	6	0.15%
141	6	0.15%
28	5	0.13%
34	5	0.13%
47	5	0.13%
49	5	0.13%
50	5	0.13%
64	5	0.13%
102	5	0.13%
113	5	0.13%
120	5	0.13%
124	5	0.13%
151	5	0.13%
42	4	0.10%
56	4	0.10%
60	4	0.10%
66	4	0.10%
78	4	0.10%
85	4	0.10%
99	4	0.10%
100	4	0.10%
105	4	0.10%
117	4	0.10%
125	4	0.10%
37	3	0.08%
44	3	0.08%
51	3	0.08%
54	3	0.08%

Visitor Use Area	Stops per VUA	% Stops Per VUA
97	3	0.08%
108	3	0.08%
111	3	0.08%
139	3	0.08%
142	3	0.08%
152	3	0.08%
16	2	0.05%
39	2	0.05%
46	2	0.05%
57	2	0.05%
58	2	0.05%
59	2	0.05%
79	2	0.05%
80	2	0.05%
82	2	0.05%
98	2	0.05%
126	2	0.05%
133	2	0.05%
134	2	0.05%
136	2	0.05%
45	1	0.03%
63	1	0.03%
72	1	0.03%
81	1	0.03%
83	1	0.03%
84	1	0.03%
86	1	0.03%
122	1	0.03%
140	1	0.03%

Number of trips to each Visitor Use Area from Whittier

Rank	Visitor Use Area	Number of Trips	Percentage
1	147	470	28.69%
2	22	79	4.82%
3	25	62	3.79%
4	148	59	3.60%
5	146	56	3.42%
6	1	52	3.17%
7	150	48	2.93%
8	27	41	2.50%
9	2	38	2.32%
10	3	33	2.01%
11	19	31	1.89%
12	17	28	1.71%
13	18	22	1.34%
14	24	22	1.34%
15	31	22	1.34%
16	143	21	1.28%
17	88	20	1.22%
18	8	18	1.10%
19	65	18	1.10%
20	87	16	0.98%
21	90	15	0.92%
22	144	15	0.92%
23	11	14	0.85%
24	12	14	0.85%
25	21	14	0.85%
26	23	14	0.85%
27	4	13	0.79%
28	9	13	0.79%
29	30	13	0.79%
30	68	13	0.79%
31	38	12	0.73%
32	67	12	0.73%
33	5	11	0.67%
34	6	11	0.67%
35	69	11	0.67%
36	89	11	0.67%
37	20	10	0.61%
38	26	10	0.61%
39	14	9	0.55%
40	71	9	0.55%
41	91	9	0.55%
42	7	8	0.49%
43	15	8	0.49%
44	41	8	0.49%
45	52	8	0.49%
46	53	8	0.49%
47	13	7	0.43%
48	62	7	0.43%
49	93	7	0.43%
50	10	6	0.37%
51	35	6	0.37%
52	36	6	0.37%
53	109	6	0.37%
54	145	6	0.37%
55	40	5	0.31%
56	48	5	0.31%
57	116	5	0.31%
58	151	5	0.31%
59	28	4	0.24%
60	29	4	0.24%
61	32	4	0.24%
62	33	4	0.24%
63	61	4	0.24%
64	66	4	0.24%
65	94	4	0.24%
66	95	4	0.24%
67	113	4	0.24%
68	141	4	0.24%
69	37	3	0.18%
70	42	3	0.18%
71	43	3	0.18%
72	47	3	0.18%
73	49	3	0.18%
74	54	3	0.18%
75	55	3	0.18%
76	56	3	0.18%
77	60	3	0.18%
78	64	3	0.18%
79	85	3	0.18%
80	139	3	0.18%

Rank	Visitor Use Area	Number of Trips	Percentage
81	34	2	0.12%
82	39	2	0.12%
83	44	2	0.12%
84	51	2	0.12%
85	58	2	0.12%
86	59	2	0.12%
87	92	2	0.12%
88	96	2	0.12%
89	97	2	0.12%
90	114	2	0.12%
91	133	2	0.12%
92	142	2	0.12%
93	152	2	0.12%
94	16	1	0.06%
95	50	1	0.06%
96	57	1	0.06%
97	74	1	0.06%
98	80	1	0.06%
99	84	1	0.06%
100	103	1	0.06%
101	106	1	0.06%
102	110	1	0.06%
103	111	1	0.06%
104	120	1	0.06%
105	122	1	0.06%
106	129	1	0.06%
107	131	1	0.06%
108	137	1	0.06%
109	140	1	0.06%

Number of stops in each Visitor Use Area from Whittier

Rank	Visitor Use Area	Number of Stops	Percentage
1	147	1076	40.41%
2	150	124	4.66%
3	22	121	4.54%
4	25	87	3.27%
5	146	82	3.08%
6	1	80	3.00%
7	148	71	2.67%
8	3	51	1.92%
9	27	51	1.92%
10	2	46	1.73%
11	19	35	1.31%
12	143	33	1.24%
13	17	29	1.09%
14	144	28	1.05%
15	8	27	1.01%
16	31	25	0.94%
17	24	23	0.86%
18	71	23	0.86%
19	18	22	0.83%
20	87	22	0.83%
21	88	22	0.83%
22	65	21	0.79%
23	68	21	0.79%
24	69	18	0.68%
25	11	17	0.64%
26	38	16	0.60%
27	89	16	0.60%
28	21	15	0.56%
29	23	15	0.56%
30	90	15	0.56%
31	4	14	0.53%
32	9	14	0.53%
33	12	14	0.53%
34	26	14	0.53%
35	53	14	0.53%
36	67	14	0.53%
37	91	14	0.53%
38	5	13	0.49%
39	14	13	0.49%
40	30	13	0.49%
41	7	12	0.45%
42	20	12	0.45%
43	6	11	0.41%
44	52	10	0.38%
45	41	9	0.34%
46	93	9	0.34%
47	10	8	0.30%
48	15	8	0.30%
49	35	8	0.30%
50	62	8	0.30%
51	13	7	0.26%
52	36	7	0.26%
53	61	7	0.26%
54	116	7	0.26%
55	33	6	0.23%
56	40	6	0.23%
57	48	6	0.23%
58	95	6	0.23%
59	109	6	0.23%
60	114	6	0.23%
61	141	6	0.23%
62	145	6	0.23%
63	28	5	0.19%
64	29	5	0.19%
65	32	5	0.19%
66	43	5	0.19%
67	151	5	0.19%
68	42	4	0.15%
69	55	4	0.15%
70	56	4	0.15%
71	60	4	0.15%
72	66	4	0.15%
73	85	4	0.15%
74	94	4	0.15%
75	113	4	0.15%
76	37	3	0.11%
77	47	3	0.11%
78	49	3	0.11%
79	51	3	0.11%
80	54	3	0.11%

Rank	Visitor Use Area	Number of Stops	Percentage
81	64	3	0.11%
82	110	3	0.11%
83	129	3	0.11%
84	139	3	0.11%
85	152	3	0.11%
86	34	2	0.08%
87	39	2	0.08%
88	44	2	0.08%
89	50	2	0.08%
90	58	2	0.08%
91	59	2	0.08%
92	92	2	0.08%
93	96	2	0.08%
94	97	2	0.08%
95	111	2	0.08%
96	133	2	0.08%
97	137	2	0.08%
98	142	2	0.08%
99	16	1	0.04%
100	57	1	0.04%
101	74	1	0.04%
102	80	1	0.04%
103	84	1	0.04%
104	103	1	0.04%
105	106	1	0.04%
106	120	1	0.04%
107	122	1	0.04%
108	131	1	0.04%

Number of trips to each Visitor Use Area from Valdez

Rank	Visitor Use Area	Number of Trips	Percentage
1	109	205	36.54%
2	112	45	8.02%
3	110	41	7.31%
4	129	31	5.53%
5	128	19	3.39%
6	70	16	2.85%
7	130	16	2.85%
8	107	13	2.32%
9	74	11	1.96%
10	73	8	1.43%
11	76	8	1.43%
12	93	7	1.25%
13	61	6	1.07%
14	104	6	1.07%
15	123	6	1.07%
16	127	6	1.07%
17	131	6	1.07%
18	137	6	1.07%
19	75	5	0.89%
20	116	5	0.89%
21	92	4	0.71%
22	99	4	0.71%
23	100	4	0.71%
24	101	4	0.71%
25	102	4	0.71%
26	105	4	0.71%
27	106	4	0.71%
28	11	3	0.53%
29	65	3	0.53%
30	69	3	0.53%
31	91	3	0.53%
32	94	3	0.53%
33	95	3	0.53%
34	96	3	0.53%
35	124	3	0.53%
36	125	3	0.53%
37	132	3	0.53%
38	147	3	0.53%
39	55	2	0.36%
40	67	2	0.36%
41	79	2	0.36%
42	98	2	0.36%
43	103	2	0.36%
44	108	2	0.36%
45	119	2	0.36%
46	120	2	0.36%
47	16	1	0.18%
48	23	1	0.18%
49	31	1	0.18%
50	36	1	0.18%
51	38	1	0.18%
52	52	1	0.18%
53	53	1	0.18%
54	57	1	0.18%
55	63	1	0.18%
56	71	1	0.18%
57	72	1	0.18%
58	80	1	0.18%
59	81	1	0.18%
60	97	1	0.18%
61	111	1	0.18%
62	126	1	0.18%
63	138	1	0.18%
64	142	1	0.18%

Number of stops in each Visitor Use Area from Valdez

Rank	Visitor Use Area	Number of stops	Percentage
1	109	509	52.91%
2	112	61	6.34%
3	110	53	5.51%
4	129	36	3.74%
5	130	22	2.29%
6	128	21	2.18%
7	70	19	1.98%
8	107	19	1.98%
9	76	15	1.56%
10	74	14	1.46%
11	61	13	1.35%
12	93	11	1.14%
13	73	9	0.94%
14	137	9	0.94%
15	11	7	0.73%
16	75	7	0.73%
17	92	7	0.73%
18	127	7	0.73%
19	101	6	0.62%
20	103	6	0.62%
21	104	6	0.62%
22	106	6	0.62%
23	123	6	0.62%
24	91	5	0.52%
25	102	5	0.52%
26	124	5	0.52%
27	131	5	0.52%
28	132	5	0.52%
29	94	4	0.42%
30	99	4	0.42%
31	100	4	0.42%
32	105	4	0.42%
33	116	4	0.42%
34	65	3	0.31%
35	69	3	0.31%
36	95	3	0.31%
37	96	3	0.31%
38	108	3	0.31%
39	125	3	0.31%
40	36	2	0.21%

Rank	Visitor Use Area	Number of stops	Percentage
41	55	2	0.21%
42	67	2	0.21%
43	79	2	0.21%
44	98	2	0.21%
45	120	2	0.21%
46	147	2	0.21%
47	16	1	0.10%
48	23	1	0.10%
49	31	1	0.10%
50	38	1	0.10%
51	52	1	0.10%
52	53	1	0.10%
53	57	1	0.10%
54	63	1	0.10%
55	72	1	0.10%
56	80	1	0.10%
57	81	1	0.10%
58	97	1	0.10%
59	111	1	0.10%
60	119	1	0.10%
61	126	1	0.10%
62	142	1	0.10%

Number of trips to each Visitor Use Area from Cordova

Rank	Visitor Use Area	Number of trips	Percentage
1	116	35	36.84%
2	114	14	14.74%
3	118	7	7.37%
4	115	6	6.32%
5	77	4	4.21%
6	117	4	4.21%
7	119	4	4.21%
8	78	2	2.11%
9	121	2	2.11%
10	134	2	2.11%
11	136	2	2.11%
12	6	1	1.05%
13	7	1	1.05%
14	71	1	1.05%
15	76	1	1.05%
16	91	1	1.05%
17	109	1	1.05%
18	120	1	1.05%
19	125	1	1.05%
20	126	1	1.05%
21	132	1	1.05%
22	143	1	1.05%
23	144	1	1.05%
24	147	1	1.05%

Number of stops in each Visitor Use Area from Cordova

Rank	Visitor Use Area	Number of Stops	Percent
1	116	67	43.23%
2	114	20	12.90%
3	121	11	7.10%
4	118	9	5.81%
5	115	7	4.52%
6	77	6	3.87%
7	119	5	3.23%
8	78	4	2.58%
9	117	4	2.58%
10	144	3	1.94%
11	147	3	1.94%
12	120	2	1.29%
13	134	2	1.29%
14	136	2	1.29%
15	6	1	0.65%
16	7	1	0.65%
17	71	1	0.65%
18	76	1	0.65%
19	91	1	0.65%
20	109	1	0.65%
21	125	1	0.65%
22	126	1	0.65%
23	132	1	0.65%
24	143	1	0.65%

Number of trips taken by Cruisers to each Visitor Use Area

Rank	Visitor Use Area	Number of Trips	Percentage
1	147	33	11.04%
2	109	31	10.37%
3	116	14	4.68%
4	112	9	3.01%
5	146	8	2.68%
6	110	7	2.34%
7	129	6	2.01%
8	2	6	2.01%
9	150	5	1.67%
10	118	5	1.67%
11	114	5	1.67%
12	74	5	1.67%
13	18	5	1.67%
14	148	4	1.34%
15	107	4	1.34%
16	104	4	1.34%
17	38	4	1.34%
18	31	4	1.34%
19	22	4	1.34%
20	12	4	1.34%
21	11	4	1.34%
22	8	4	1.34%
23	115	3	1.00%
24	99	3	1.00%
25	95	3	1.00%
26	76	3	1.00%
27	70	3	1.00%
28	20	3	1.00%
29	19	3	1.00%
30	3	3	1.00%
31	1	3	1.00%
32	145	2	0.67%
33	143	2	0.67%
34	131	2	0.67%
35	124	2	0.67%
36	106	2	0.67%
37	102	2	0.67%
38	96	2	0.67%
39	91	2	0.67%
40	78	2	0.67%
41	57	2	0.67%
42	55	2	0.67%
43	52	2	0.67%
44	50	2	0.67%
45	47	2	0.67%
46	35	2	0.67%
47	25	2	0.67%
48	24	2	0.67%
49	17	2	0.67%
50	13	2	0.67%
51	10	2	0.67%
52	9	2	0.67%
53	7	2	0.67%
54	6	2	0.67%
55	144	1	0.33%
56	141	1	0.33%
57	140	1	0.33%
58	137	1	0.33%
59	136	1	0.33%
60	134	1	0.33%
61	127	1	0.33%
62	123	1	0.33%
63	120	1	0.33%
64	119	1	0.33%
65	117	1	0.33%
66	113	1	0.33%
67	108	1	0.33%
68	105	1	0.33%
69	103	1	0.33%
70	101	1	0.33%
71	98	1	0.33%
72	97	1	0.33%
73	94	1	0.33%
74	93	1	0.33%
75	92	1	0.33%
76	90	1	0.33%
77	87	1	0.33%
78	85	1	0.33%

Rank	Visitor Use Area	Number of Trips	Percentage
79	83	1	0.33%
80	75	1	0.33%
81	72	1	0.33%
82	64	1	0.33%
83	63	1	0.33%
84	62	1	0.33%
85	61	1	0.33%
86	54	1	0.33%
87	53	1	0.33%
88	51	1	0.33%
89	48	1	0.33%
90	46	1	0.33%
91	44	1	0.33%
92	43	1	0.33%
93	42	1	0.33%
94	41	1	0.33%
95	37	1	0.33%
96	36	1	0.33%
97	34	1	0.33%
98	33	1	0.33%
99	32	1	0.33%
100	26	1	0.33%
101	23	1	0.33%
102	16	1	0.33%
103	15	1	0.33%
104	5	1	0.33%
105	4	1	0.33%

Number of stops taken by Cruisers in each Visitor Use Area

Rank	Visitor Use Area	Number of Stops	Percentage
1	147	69	14.44%
2	109	65	13.60%
3	116	26	5.44%
4	112	20	4.18%
5	150	15	3.14%
6	146	12	2.51%
7	110	11	2.30%
8	76	9	1.88%
9	114	9	1.88%
10	129	8	1.67%
11	3	7	1.46%
12	61	7	1.46%
13	74	7	1.46%
14	2	6	1.26%
15	11	6	1.26%
16	22	6	1.26%
17	1	5	1.05%
18	18	5	1.05%
19	31	5	1.05%
20	50	5	1.05%
21	70	5	1.05%
22	103	5	1.05%
23	107	5	1.05%
24	118	5	1.05%
25	143	5	1.05%
26	148	5	1.05%
27	8	4	0.84%
28	10	4	0.84%
29	12	4	0.84%
30	38	4	0.84%
31	78	4	0.84%
32	95	4	0.84%
33	104	4	0.84%
34	106	4	0.84%
35	115	4	0.84%
36	124	4	0.84%
37	19	3	0.63%
38	20	3	0.63%
39	25	3	0.63%
40	43	3	0.63%
41	52	3	0.63%
42	99	3	0.63%
43	6	2	0.42%
44	7	2	0.42%
45	9	2	0.42%
46	13	2	0.42%
47	17	2	0.42%
48	24	2	0.42%
49	35	2	0.42%
50	42	2	0.42%
51	46	2	0.42%
52	47	2	0.42%
53	51	2	0.42%
54	55	2	0.42%
55	57	2	0.42%
56	87	2	0.42%
57	91	2	0.42%
58	93	2	0.42%
59	94	2	0.42%
60	96	2	0.42%
61	101	2	0.42%
62	102	2	0.42%
63	123	2	0.42%
64	131	2	0.42%
65	144	2	0.42%
66	145	2	0.42%
67	4	1	0.21%
68	5	1	0.21%
69	15	1	0.21%
70	16	1	0.21%
71	23	1	0.21%
72	26	1	0.21%
73	32	1	0.21%
74	33	1	0.21%
75	34	1	0.21%
76	36	1	0.21%
77	37	1	0.21%
78	41	1	0.21%

Rank	Visitor Use Area	Number of Stops	Percentage
79	44	1	0.21%
80	48	1	0.21%
81	53	1	0.21%
82	54	1	0.21%
83	62	1	0.21%
84	63	1	0.21%
85	64	1	0.21%
86	72	1	0.21%
87	75	1	0.21%
88	83	1	0.21%
89	85	1	0.21%
90	90	1	0.21%
91	92	1	0.21%
92	97	1	0.21%
93	98	1	0.21%
94	105	1	0.21%
95	108	1	0.21%
96	113	1	0.21%
97	117	1	0.21%
98	119	1	0.21%
99	120	1	0.21%
100	127	1	0.21%
101	134	1	0.21%
102	136	1	0.21%
103	137	1	0.21%
104	140	1	0.21%
105	141	1	0.21%

Number of trips taken by Fishers/Hunters to each Visitor Use Area

Rank	Visitor Use Area	Number of Trips	Percentage
1	147	274	20.19%
2	109	126	9.29%
3	22	51	3.76%
4	148	48	3.54%
5	25	45	3.32%
6	1	36	2.65%
7	27	29	2.14%
8	112	26	1.92%
9	150	26	1.92%
10	146	24	1.77%
11	3	22	1.62%
12	19	22	1.62%
13	116	22	1.62%
14	110	20	1.47%
15	17	18	1.33%
16	65	18	1.33%
17	129	18	1.33%
18	88	16	1.18%
19	2	15	1.11%
20	24	14	1.03%
21	18	13	0.96%
22	31	13	0.96%
23	128	13	0.96%
24	130	13	0.96%
25	30	12	0.88%
26	87	12	0.88%
27	70	11	0.81%
28	89	11	0.81%
29	90	11	0.81%
30	21	10	0.74%
31	23	10	0.74%
32	69	10	0.74%
33	91	10	0.74%
34	8	9	0.66%
35	61	9	0.66%
36	93	9	0.66%
37	9	8	0.59%
38	11	8	0.59%
39	38	8	0.59%
40	71	8	0.59%
41	67	7	0.52%
42	68	7	0.52%
43	107	7	0.52%
44	20	6	0.44%
45	26	6	0.44%
46	92	6	0.44%
47	94	6	0.44%
48	114	6	0.44%
49	119	6	0.44%
50	137	6	0.44%
51	5	5	0.37%
52	36	5	0.37%
53	76	5	0.37%
54	143	5	0.37%
55	144	5	0.37%
56	151	5	0.37%
57	4	4	0.29%
58	6	4	0.29%
59	13	4	0.29%
60	14	4	0.29%
61	15	4	0.29%
62	32	4	0.29%
63	35	4	0.29%
64	52	4	0.29%
65	53	4	0.29%
66	66	4	0.29%
67	73	4	0.29%
68	74	4	0.29%
69	77	4	0.29%
70	96	4	0.29%
71	100	4	0.29%
72	123	4	0.29%
73	132	4	0.29%
74	12	3	0.22%
75	28	3	0.22%
76	29	3	0.22%
77	41	3	0.22%
78	48	3	0.22%

Rank	Visitor Use Area	Number of Trips	Percentage
79	60	3	0.22%
80	62	3	0.22%
81	95	3	0.22%
82	105	3	0.22%
83	115	3	0.22%
84	120	3	0.22%
85	125	3	0.22%
86	127	3	0.22%
87	131	3	0.22%
88	141	3	0.22%
89	142	3	0.22%
90	10	2	0.15%
91	33	2	0.15%
92	34	2	0.15%
93	39	2	0.15%
94	40	2	0.15%
95	43	2	0.15%
96	56	2	0.15%
97	58	2	0.15%
98	59	2	0.15%
99	75	2	0.15%
100	79	2	0.15%
101	80	2	0.15%
102	97	2	0.15%
103	101	2	0.15%
104	102	2	0.15%
105	104	2	0.15%
106	111	2	0.15%
107	113	2	0.15%
108	117	2	0.15%
109	118	2	0.15%
110	126	2	0.15%
111	139	2	0.15%
112	145	2	0.15%
113	7	1	0.07%
114	16	1	0.07%
115	37	1	0.07%
116	44	1	0.07%
117	45	1	0.07%
118	47	1	0.07%
119	51	1	0.07%
120	55	1	0.07%
121	64	1	0.07%

Rank	Visitor Use Area	Number of Trips	Percentage
122	81	1	0.07%
123	82	1	0.07%
124	84	1	0.07%
125	85	1	0.07%
126	98	1	0.07%
127	99	1	0.07%
128	103	1	0.07%
129	106	1	0.07%
130	108	1	0.07%
131	121	1	0.07%
132	134	1	0.07%
133	136	1	0.07%
134	138	1	0.07%
135	140	1	0.07%
136	152	1	0.07%

Number of stops taken by Fishers/Hunters in each Visitor Use Area

Rank	Visitor Use Area	Number of Stops	Percentage
1	147	614	26.88%
2	109	331	14.49%
3	22	80	3.50%
4	150	79	3.46%
5	25	64	2.80%
6	148	60	2.63%
7	1	58	2.54%
8	116	40	1.75%
9	71	38	1.66%
10	146	38	1.66%
11	27	37	1.62%
12	3	34	1.49%
13	112	31	1.36%
14	110	26	1.14%
15	19	25	1.09%
16	129	22	0.96%
17	65	21	0.92%
18	2	20	0.88%
19	17	19	0.83%
20	88	18	0.79%
21	91	18	0.79%
22	130	18	0.79%
23	11	16	0.70%
24	89	16	0.70%
25	24	15	0.66%
26	31	15	0.66%
27	128	15	0.66%
28	8	13	0.57%
29	18	13	0.57%
30	61	13	0.57%
31	87	13	0.57%
32	93	13	0.57%
33	30	12	0.53%
34	38	12	0.53%
35	69	12	0.53%
36	70	12	0.53%
37	21	11	0.48%
38	23	11	0.48%
39	68	11	0.48%
40	90	11	0.48%
41	144	11	0.48%
42	121	10	0.44%
43	137	10	0.44%
44	26	9	0.39%
45	92	9	0.39%
46	9	8	0.35%
47	20	8	0.35%
48	36	8	0.35%
49	67	8	0.35%
50	107	8	0.35%
51	114	8	0.35%
52	5	7	0.31%
53	53	7	0.31%
54	119	7	0.31%
55	143	7	0.31%
56	14	6	0.26%
57	35	6	0.26%
58	76	6	0.26%
59	77	6	0.26%
60	94	6	0.26%
61	132	6	0.26%
62	141	6	0.26%
63	151	6	0.26%
64	32	5	0.22%
65	52	5	0.22%
66	4	4	0.18%
67	6	4	0.18%
68	13	4	0.18%
69	15	4	0.18%
70	28	4	0.18%
71	29	4	0.18%
72	41	4	0.18%
73	48	4	0.18%
74	60	4	0.18%
75	66	4	0.18%
76	73	4	0.18%
77	74	4	0.18%
78	75	4	0.18%

Rank	Visitor Use Area	Number of Stops	Percentage
79	95	4	0.18%
80	96	4	0.18%
81	100	4	0.18%
82	118	4	0.18%
83	120	4	0.18%
84	123	4	0.18%
85	127	4	0.18%
86	7	3	0.13%
87	12	3	0.13%
88	40	3	0.13%
89	62	3	0.13%
90	101	3	0.13%
91	102	3	0.13%
92	105	3	0.13%
93	111	3	0.13%
94	115	3	0.13%
95	125	3	0.13%
96	131	3	0.13%
97	142	3	0.13%
98	10	2	0.09%
99	33	2	0.09%
100	34	2	0.09%
101	39	2	0.09%
102	43	2	0.09%
103	56	2	0.09%
104	58	2	0.09%
105	59	2	0.09%
106	79	2	0.09%
107	80	2	0.09%
108	82	2	0.09%
109	85	2	0.09%
110	97	2	0.09%
111	104	2	0.09%
112	108	2	0.09%
113	113	2	0.09%
114	117	2	0.09%
115	126	2	0.09%
116	139	2	0.09%
117	145	2	0.09%
118	152	2	0.09%
119	16	1	0.04%
120	37	1	0.04%
121	44	1	0.04%
122	45	1	0.04%
123	47	1	0.04%
124	51	1	0.04%
125	55	1	0.04%
126	64	1	0.04%
127	81	1	0.04%
128	84	1	0.04%
129	98	1	0.04%
130	99	1	0.04%
131	103	1	0.04%
132	106	1	0.04%
133	134	1	0.04%
134	136	1	0.04%
135	138	1	0.04%
136	140	1	0.04%

Number of trips taken by Paddlers to each Visitor Use Area

Rank	Visitor Use Area	Number of Trips	Percentage
1	147	32	18.39%
2	144	11	6.32%
3	143	10	5.75%
4	146	10	5.75%
5	6	7	4.02%
6	109	7	4.02%
7	145	6	3.45%
8	150	6	3.45%
9	2	5	2.87%
10	4	5	2.87%
11	22	5	2.87%
12	148	5	2.87%
13	110	4	2.30%
14	1	3	1.72%
15	3	3	1.72%
16	7	3	1.72%
17	8	3	1.72%
18	9	3	1.72%
19	10	3	1.72%
20	12	3	1.72%
21	129	3	1.72%
22	5	2	1.15%
23	11	2	1.15%
24	18	2	1.15%
25	25	2	1.15%
26	53	2	1.15%
27	64	2	1.15%
28	67	2	1.15%
29	68	2	1.15%
30	113	2	1.15%
31	14	1	0.57%
32	15	1	0.57%
33	21	1	0.57%
34	23	1	0.57%
35	29	1	0.57%
36	34	1	0.57%
37	36	1	0.57%
38	41	1	0.57%
39	43	1	0.57%
40	48	1	0.57%
41	49	1	0.57%
42	86	1	0.57%
43	88	1	0.57%
44	93	1	0.57%
45	101	1	0.57%
46	106	1	0.57%
47	107	1	0.57%
48	114	1	0.57%
49	116	1	0.57%

Number of stops taken by Paddlers in each Visitor Use Area

Rank	Visitor Use Area	Number of Stops	Percentage
1	147	110	27.09%
2	144	40	9.85%
3	146	34	8.37%
4	143	28	6.90%
5	150	24	5.91%
6	109	15	3.69%
7	22	11	2.71%
8	110	11	2.71%
9	6	9	2.22%
10	114	8	1.97%
11	3	7	1.72%
12	7	7	1.72%
13	25	7	1.72%
14	67	7	1.72%
15	2	6	1.48%
16	8	6	1.48%
17	116	6	1.48%
18	145	6	1.48%
19	4	5	1.23%
20	10	5	1.23%
21	129	5	1.23%
22	148	5	1.23%
23	9	4	0.99%
24	1	3	0.74%
25	12	3	0.74%
26	5	2	0.49%
27	11	2	0.49%
28	14	2	0.49%
29	18	2	0.49%
30	34	2	0.49%
31	49	2	0.49%
32	53	2	0.49%
33	64	2	0.49%
34	68	2	0.49%
35	113	2	0.49%
36	15	1	0.25%
37	21	1	0.25%
38	23	1	0.25%
39	29	1	0.25%
40	36	1	0.25%
41	41	1	0.25%
42	43	1	0.25%
43	48	1	0.25%
44	86	1	0.25%
45	88	1	0.25%
46	93	1	0.25%
47	101	1	0.25%
48	106	1	0.25%
49	107	1	0.25%

Appendix B: Visitor Use Area acreages and the number of stops and wildlife nest sites within this Sound

Visitor Use Area	Acres (sq km)	Stop Per Acre	Bald Eagle Nest Sites Per Acre	Black Oystercatchers Nest Sites Per Acre	Harbor Seal Haul-Out Sites Per Acre	Cutthroat Trout Streams Per Acre	Pigeon Guillemot Nest Sites Per Acre
1	5638.4	14.2	0.0	0.0	0.0	0.0	0.0
2	1860.0	25.3	0.0	0.0	0.0	0.0	0.0
3	15617.3	3.5	0.3	0.0	0.0	0.0	0.1
4	2472.9	5.7	0.0	0.0	0.0	0.0	0.0
5	4113.0	3.2	0.0	0.0	0.0	0.0	0.0
6	1358.7	11.8	1.5	0.0	0.0	0.0	0.0
7	2236.6	8.0	0.9	0.0	0.0	0.0	0.0
8	3439.0	7.9	0.3	0.0	0.0	0.0	0.0
9	2128.3	7.0	0.0	0.0	0.0	0.0	0.0
10	23742.7	0.4	0.2	0.0	0.1	0.0	0.1
11	20022.7	1.4	0.4	0.1	0.1	0.0	0.0
12	4843.3	2.9	0.0	0.0	0.0	0.0	0.0
13	1309.9	5.3	0.0	0.0	0.0	0.0	0.0
14	3681.4	3.5	0.0	0.0	0.0	0.0	0.0
15	2359.5	3.4	1.7	2.5	0.4	0.0	0.8
16	2070.0	1.0	1.0	0.0	0.0	0.0	0.5
17	6227.9	4.7	2.1	0.0	0.2	0.0	0.5
18	9565.5	2.4	0.1	0.0	0.0	0.0	0.0
19	2440.0	14.3	0.0	0.0	0.0	0.0	0.0
20	4697.1	2.6	1.7	0.0	0.0	0.0	1.1
21	2530.5	5.9	0.4	0.0	0.0	0.0	0.0
22	9476.2	13.7	1.2	0.0	0.0	0.0	0.0
23	2280.7	7.0	0.4	0.0	0.0	0.0	0.0
24	2897.9	7.9	1.4	0.0	0.0	0.0	0.0
25	6737.5	14.0	1.0	0.0	0.1	0.0	0.0
26	4951.2	3.0	0.0	0.0	0.0	0.0	0.0
27	3748.5	13.6	1.1	0.0	0.0	0.0	0.0
28	2040.5	2.5	2.5	0.5	0.0	0.0	0.0
29	1567.3	3.8	0.6	0.0	0.0	0.0	0.0
30	2755.0	4.7	1.8	0.0	0.4	0.0	0.0
31	4857.8	5.6	2.7	0.0	0.0	0.0	0.0
32	3016.4	2.0	0.3	0.0	0.0	0.0	0.0
33	3198.0	2.2	1.9	0.0	0.0	0.0	0.0
34	5061.6	1.0	0.2	0.0	0.2	0.0	0.0
35	9780.2	0.9	0.4	0.0	0.1	0.0	0.1

Visitor Use Area	Acres (sq km)	Stop Per Acre	Bald Eagle Nest Sites Per Acre	Black Oystercatchers Nest Sites Per Acre	Harbor Seal Haul-Out Sites Per Acre	Cutthroat Trout Streams Per Acre	Pigeon Guillemot Nest Sites Per Acre
36	11365.0	1.1	0.4	0.1	0.0	0.0	0.1
37	3764.5	0.8	1.9	0.0	0.0	0.0	0.0
38	4245.4	4.2	0.9	0.5	0.2	0.0	0.2
39	1124.3	1.8	1.8	0.0	0.9	0.0	0.0
40	3099.2	1.9	2.6	0.0	0.3	0.0	0.0
41	2883.0	3.5	2.1	0.0	0.0	0.0	0.0
42	2659.1	1.5	0.0	0.0	0.0	0.0	0.0
43	5867.3	1.0	1.9	0.3	0.2	0.0	0.0
44	2076.9	1.4	0.0	0.0	0.5	0.0	0.0
45	1597.9	0.6	0.6	0.0	0.0	0.0	0.6
46	2341.2	0.9	0.4	0.0	0.4	0.0	0.0
47	3556.0	1.4	0.3	0.3	0.0	0.0	0.0
48	19719.4	0.4	2.2	0.2	0.2	0.0	0.1
49	3217.7	1.6	1.9	0.0	0.0	0.0	0.0
50	7816.3	0.6	0.6	0.0	0.6	0.0	0.0
51	1910.7	1.6	2.6	0.0	0.0	0.0	0.0
52	11393.8	1.0	1.6	0.2	0.0	0.0	0.1
53	9439.0	1.8	2.1	0.2	0.1	0.0	0.0
54	1974.1	1.5	1.5	0.0	0.0	0.0	0.0
55	2048.1	2.9	1.5	0.0	0.0	0.0	0.0
56	6830.1	0.6	0.0	0.0	0.0	0.0	0.0
57	825.4	2.4	2.4	0.0	0.0	0.0	0.0
58	9378.8	0.2	0.0	0.1	0.0	0.0	0.0
59	3449.2	0.6	0.3	1.7	0.0	0.0	0.0
60	8120.3	0.5	0.1	0.0	0.0	0.0	0.0
61	40184.1	0.5	0.9	0.5	0.1	0.3	0.0
62	9223.6	0.9	1.0	0.1	0.2	0.0	0.0
63	2136.1	0.5	3.3	0.0	0.0	0.0	0.5
64	8450.2	0.6	1.5	0.5	0.1	0.0	0.0
65	11641.6	2.1	1.1	0.0	0.3	0.0	0.3
66	2686.8	1.5	3.0	0.0	0.4	0.0	1.1
67	12862.7	1.8	1.6	0.4	0.2	0.0	0.0
68	10784.9	2.1	1.7	0.3	0.2	0.0	0.1
69	10089.0	2.1	2.6	0.2	0.1	0.0	0.0
70	13320.7	1.4	2.1	0.1	0.0	0.0	0.0
71	49096.2	0.5	0.3	0.1	0.0	0.1	0.0
72	1955.0	0.5	1.0	0.0	0.0	0.0	0.0
73	8531.9	1.1	0.1	0.0	0.0	0.0	0.1
74	9291.7	1.6	1.8	0.0	0.0	0.0	0.0

Visitor Use Area	Acres (sq km)	Stop Per Acre	Bald Eagle Nest Sites Per Acre	Black Oystercatchers Nest Sites Per Acre	Harbor Seal Haul-Out Sites Per Acre	Cutthroat Trout Streams Per Acre	Pigeon Guillemot Nest Sites Per Acre
75	19179.8	0.4	0.9	0.1	0.0	0.0	0.1
76	11010.0	1.5	1.5	0.1	0.0	0.0	0.0
77	14198.0	0.5	2.3	0.0	0.1	0.0	0.0
78	24112.8	0.2	0.5	0.0	0.0	1.0	0.1
79	15169.9	0.1	0.0	0.0	0.0	0.0	0.0
80	34050.1	0.1	0.0	0.0	0.0	0.0	0.0
81	26158.6	0.0	0.0	0.0	0.0	0.0	0.0
82	15668.1	0.1	0.0	0.0	0.0	0.0	0.0
83	16513.9	0.1	0.0	0.0	0.0	0.0	0.0
84	1371.8	0.7	0.0	0.0	0.0	0.0	0.0
85	1465.0	2.7	0.0	0.0	0.0	0.0	0.0
86	35.8	28.0	0.0	0.0	0.0	0.0	0.0
87	6345.3	3.5	1.9	0.2	0.0	0.0	0.0
88	5199.9	4.2	0.6	0.0	0.0	0.0	0.0
89	5649.7	2.8	1.6	0.2	0.2	0.0	0.0
90	6216.1	2.4	1.9	0.0	0.0	0.0	0.3
91	13518.4	1.7	1.9	0.1	0.0	0.0	0.6
92	13820.9	0.7	1.3	0.1	0.1	0.0	0.7
93	16803.0	1.2	1.2	0.0	0.0	0.0	0.4
94	6898.0	1.2	1.0	0.0	0.1	0.0	0.3
95	12210.8	0.7	0.4	0.0	0.2	0.0	0.0
96	5483.8	1.1	0.0	0.0	0.0	0.0	0.0
97	3350.5	0.9	0.3	0.0	0.0	0.0	0.0
98	3590.2	0.6	1.1	0.3	0.0	0.0	0.0
99	4484.2	0.9	2.0	0.0	0.0	0.0	0.0
100	5097.8	0.8	1.0	0.0	0.0	0.0	0.0
101	3578.9	1.7	0.0	0.0	0.0	0.0	0.0
102	1162.7	4.3	0.0	0.0	0.0	0.0	0.0
103	3570.9	2.0	0.3	0.0	0.0	0.0	0.0
104	2580.4	2.3	1.2	0.0	0.0	0.0	0.4
105	3756.5	1.1	0.0	0.0	0.0	0.0	0.0
106	8452.7	0.8	0.1	0.0	0.1	0.0	0.0
107	8753.1	2.3	0.7	0.7	0.0	0.0	0.0
108	1220.4	2.5	0.0	0.0	0.0	0.0	0.0
109	26628.0	19.5	0.1	0.0	0.0	0.0	0.0
110	6882.2	8.7	0.1	0.0	0.0	0.0	0.0
111	3816.8	0.8	0.3	0.0	0.3	0.0	0.0
112	14353.4	4.2	0.4	0.0	0.1	0.0	0.0
113	5143.5	1.0	0.4	0.0	0.0	0.0	0.0

Visitor Use Area	Acres (sq km)	Stop Per Acre	Bald Eagle Nest Sites Per Acre	Black Oystercatchers Nest Sites Per Acre	Harbor Seal Haul-Out Sites Per Acre	Cutthroat Trout Streams Per Acre	Pigeon Guillemot Nest Sites Per Acre
114	25088.2	1.2	1.1	0.0	0.0	0.0	0.0
115	12211.3	0.6	0.2	0.0	0.0	0.7	0.2
116	9381.2	9.0	0.4	0.0	0.0	0.1	0.0
117	6273.8	0.6	3.5	0.0	0.0	0.0	0.0
118	6591.2	1.5	2.3	0.0	0.0	0.6	0.0
119	8648.9	0.9	2.1	0.0	0.0	0.0	0.0
120	10129.7	0.5	3.9	0.0	0.2	0.0	0.0
121	10645.6	1.0	1.1	0.0	0.2	0.0	0.0
122	7699.1	0.1	0.8	0.0	0.3	0.0	0.0
123	18292.7	0.4	1.9	0.0	0.1	0.0	0.0
124	14256.5	0.4	1.5	0.1	0.1	0.0	0.0
125	11457.5	0.3	1.4	0.1	0.0	0.2	0.0
126	3013.5	0.7	2.3	0.0	0.3	2.3	0.0
127	5410.3	1.3	1.5	0.6	0.0	0.4	0.0
128	30208.6	0.7	0.7	0.1	0.1	0.1	0.0
129	7800.7	5.0	0.4	0.0	0.0	0.0	0.0
130	8952.1	2.5	0.3	0.0	0.0	0.0	0.0
131	21802.8	0.3	1.0	0.0	0.0	0.0	0.0
132	52852.9	0.1	0.5	0.0	0.0	0.3	0.1
133	10551.7	0.2	0.9	0.0	0.1	0.2	0.0
134	20763.5	0.1	0.9	0.0	0.0	1.9	0.0
135	15789.6	0.0	1.1	0.0	0.0	0.0	0.0
136	20090.0	0.1	1.1	0.0	0.1	0.4	0.0
137	58880.7	0.2	0.1	0.0	0.0	0.0	0.0
138	5254.5	0.2	0.0	0.0	0.0	0.0	0.0
139	5927.5	0.5	1.0	1.7	0.2	0.0	0.0
140	7980.4	0.3	1.8	1.6	0.3	0.9	0.1
141	13514.5	0.5	1.3	1.2	0.1	0.8	0.1
142	19466.5	0.2	0.5	0.2	0.1	0.1	0.1
143	10290.6	4.6	0.7	0.4	0.1	0.0	0.3
144	11492.8	5.0	0.4	0.9	0.1	0.0	0.3
145	5311.8	1.9	0.2	0.2	0.2	0.0	0.0
146	20505.0	5.1	0.3	0.0	0.0	0.0	0.3
147	16568.1	66.8	0.3	0.0	0.0	0.0	0.1
148	5681.2	12.7	0.2	0.0	0.0	0.0	0.0
149	3028.3	0.0	0.0	0.0	0.0	0.0	0.0
150	27122.8	5.6	0.1	0.1	0.0	0.0	0.0
151	16967.0	0.4	0.1	0.0	0.0	0.0	0.0
152	4543.4	0.7	0.0	0.0	0.0	0.0	0.0

Appendix C: Explanation and justification of Visitor Use Areas
as written by Dr. Randy Gimblett, University of Arizona.

Simulation Methodology

In order to construct a simulation, a travel network including trip destinations and trip itineraries needed to be constructed. Figure xxx illustrates all trip routes that were collected from the survey diaries.

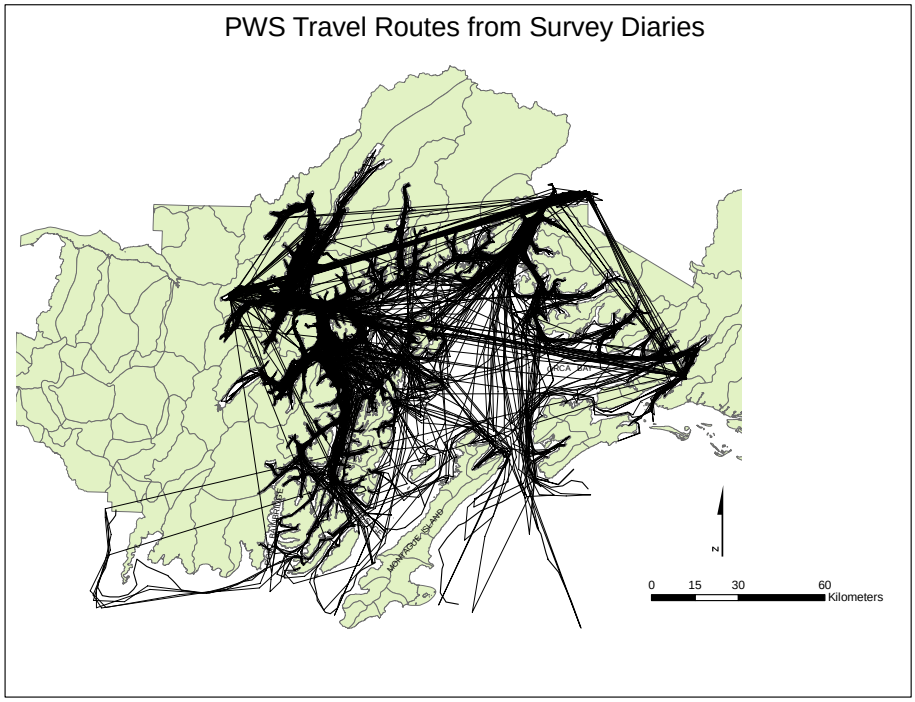


Figure C1 –Travel Routes from Survey Diaries

Trip diaries from a total of n=729 **(668)** trips were digitized and shown in Figure C1. It is clear that there are many overlapping travel routes that would be impossible to use as part of the simulation. As a result, travel routes were aggregated to reflect the major patterns of movement across the Sound. Figure C2 illustrates the final travel network derived from all 729 travel diaries. This aggregate process results in n=104 links that represent the simulation network can will be used to summarize link encounters and visitor use levels across the Sound.

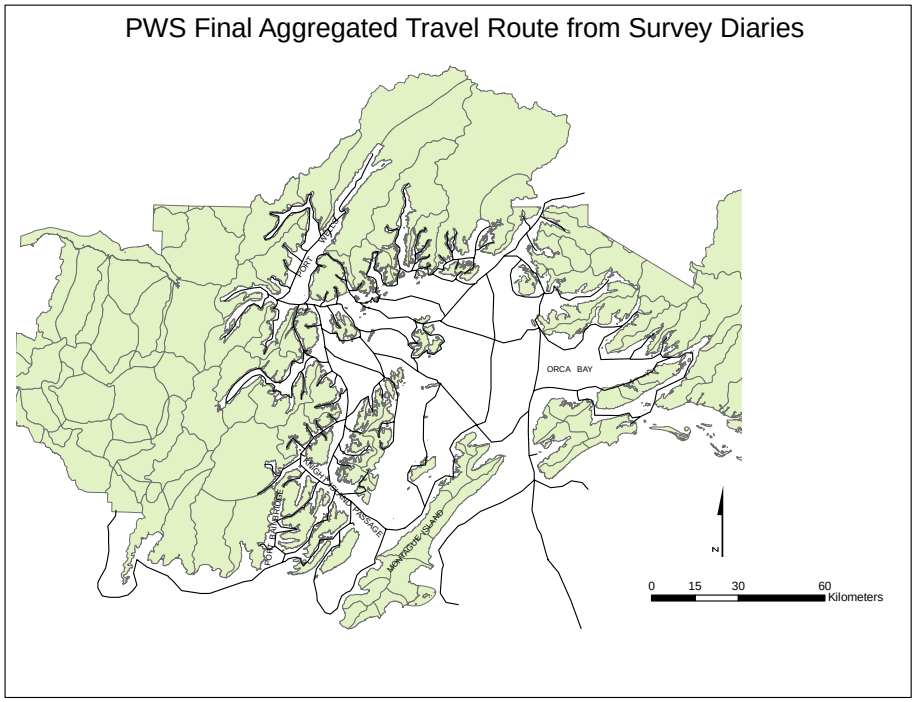


Figure C2 –Final Aggregated Travel Routes from Survey Diaries

The next step was to spatially represent all the possible stops and destinations that were recorded in the trip diaries. A total of n=4125 points were entered and mapped across the Sound. Figure C3 provides an illustration of all trip destinations. It is clear from Figure C3 that the distribution of trips across the Sound is not homogeneous. Visitors distribute themselves in a non-uniform way, suggesting that some locations or areas are more heavily used then others. Figure C4 shows the relationship of the 4125 destinations to the generalized travel network. It is apparent that to insert all 4125 points on the network would be a nightmare and result in a dramatic increase in processing during simulation runtime. So there needs to be a more efficient method created to link the destinations to the network for the simulation.

The Chugach National Forest (CNF) manages for a wide range of diverse, quality, recreational opportunities including the need to better disperse recreational in response to increased user demands. In order to accomplish this management strategy, CNF employs the concept of a capacity analysis where areas are derived using watershed associations to summarize recreation activity on CNF lands. While this has been completed for the Western Sound, work is well underway to delineate capacity areas for the Eastern Sound. Since a significant portion of recreation use is water-based, with some interaction on the land, it is imperative that the capacity area analysis take into account both.

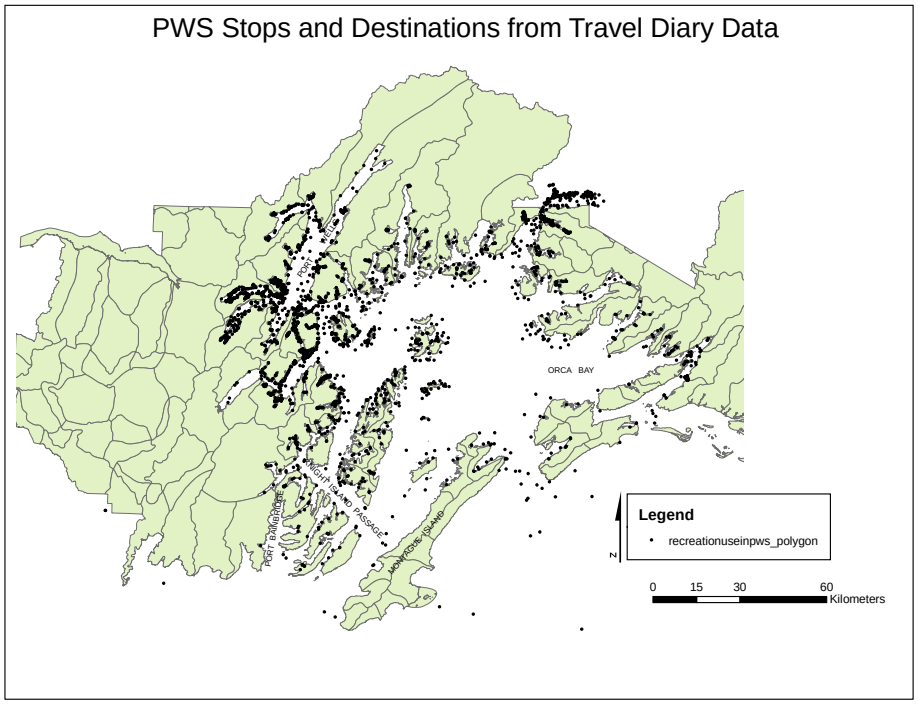


Figure C3 –Reported Trip Destinations from Travel Diary Data

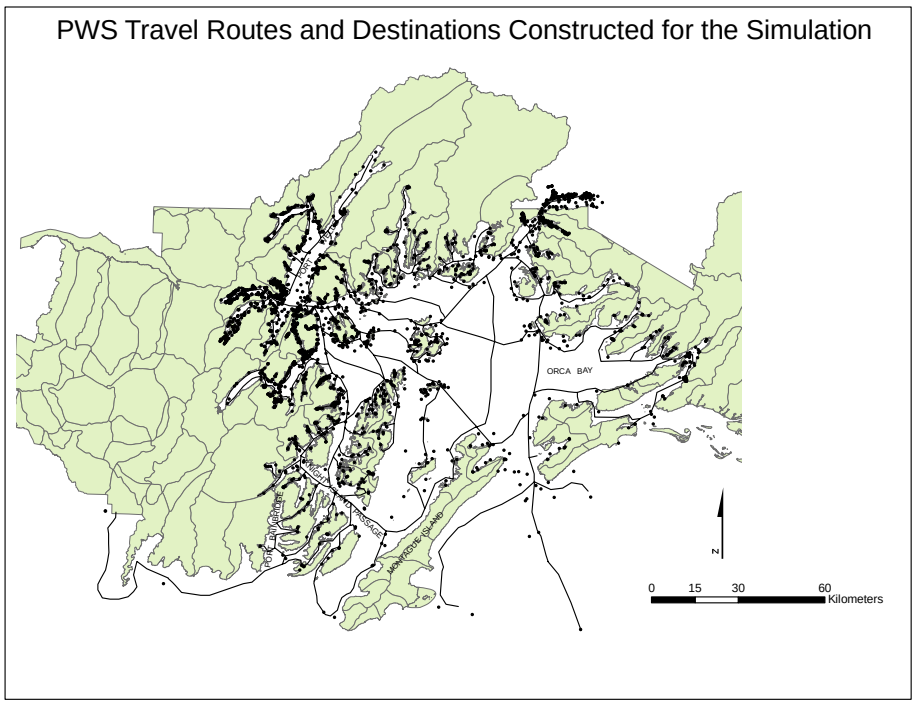


Figure C4 –Trip Destinations from Travel Diary Data on Aggregated Travel Network

In addition, with the increase in dispersed recreation use across the Sound, the capacity analysis needs to more clearly reflect the diversity and intensity of use from

the recreation visitors. Given that the Eastern Sound had not yet completed their capacity analysis, an alternate strategy was required for spatially dividing up the Sound in more concentrated use management zones that more accurately reflect the current and projected recreational use levels, intensities, durations of visit, travel modes and evaluate human interaction with wildlife, such as suggested by Cole (2004) and Steidl & Powell (2006). Since this study was deployed to capture the spatial and temporal patterns of use, it was only logical to evaluate the data collected and try to determine appropriate capacity areas.

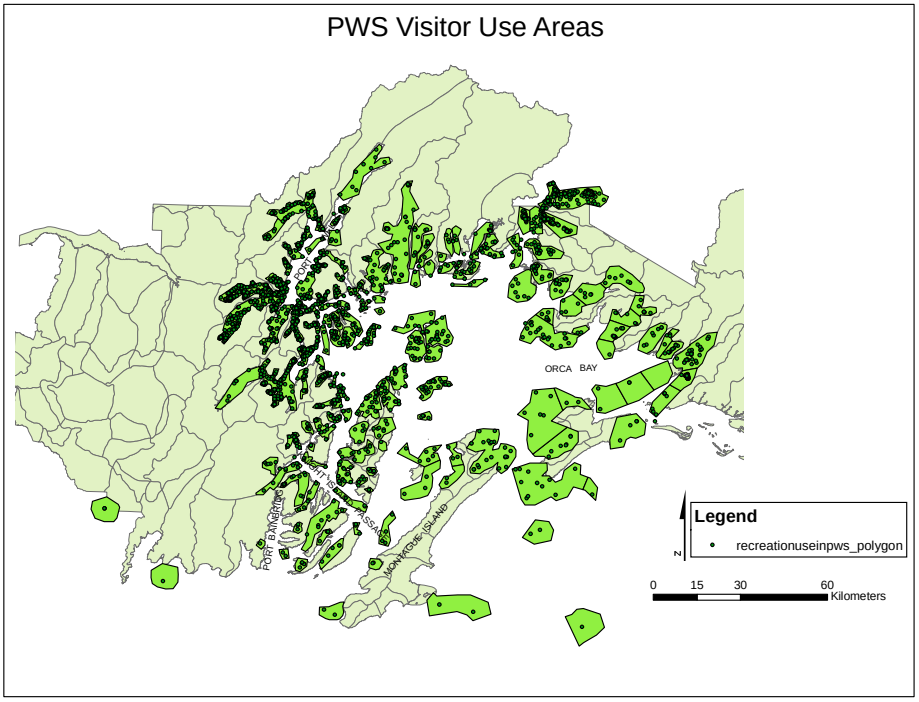


Figure C5 – Clusters of Reported Trip Destinations Used to Derive Visitor Use Areas

With this in mind a spatial clustering technique was applied to the data to aggregate these destinations into similar groups and physical features such as bays and estuaries areas that are commonly used throughout the Sound. These areas serve as destinations or because of the abundance of wildlife, protection from the weather etc. In any case, an analysis of Figure C5 shows that these destinations can be aggregated into areas that can ultimately serve as a beginning point for visitor management and open up discussions and future studies related to establishing realistic capacities. There areas can be disaggregated and then re-aggregated in the future into more realistic management zones, but for the time being they serve as a beginning point to analyze recreation use in the Sound and how water-based recreation relates to shoreline activities. Figure xx provide the mapped result of this analysis. A total of n=152 Visitor Use Areas (VUAs) were created. Much of the analysis in the second half of this report is done using these VUAs.

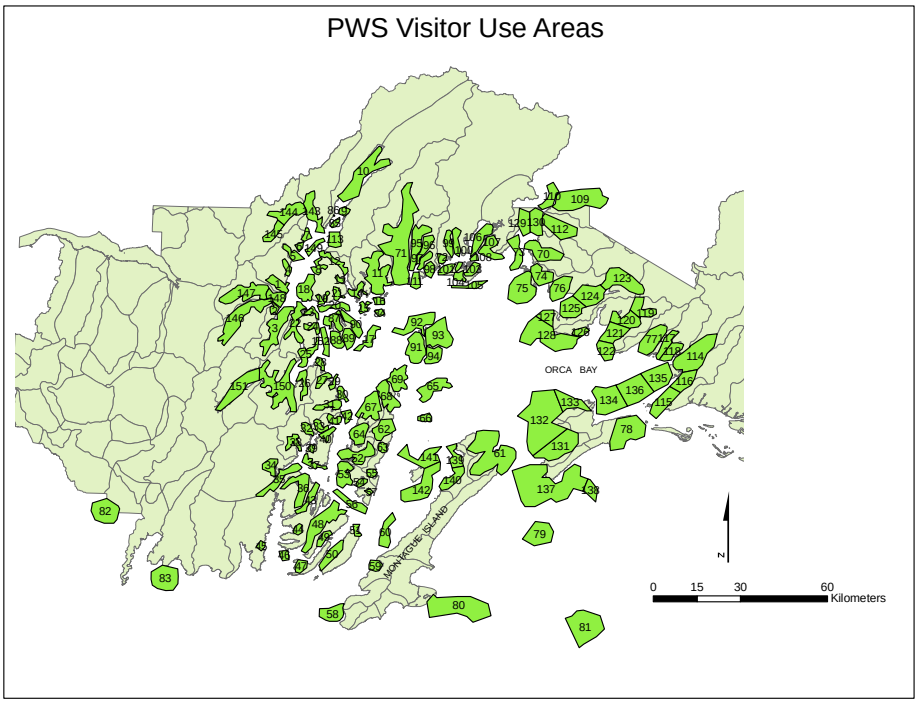


Figure C6 – Aggregation of Reported Trip Destinations to Construct Visitor Use Areas

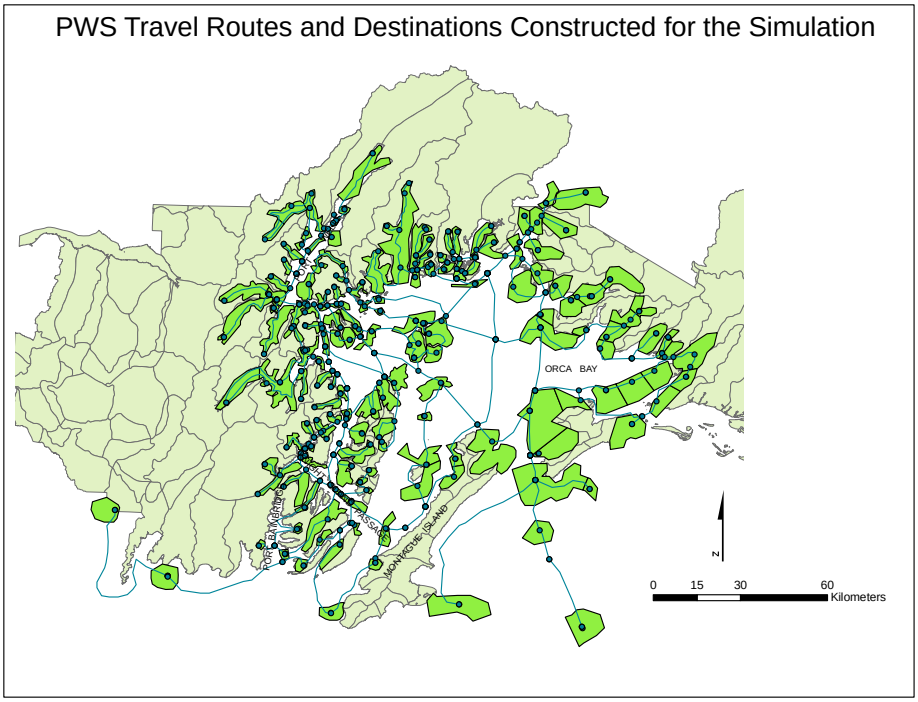


Figure C7 –Travel Routes and Destinations Constructed for the Simulation

To simplify the number of destination points on the network, a single point was associated with each of the VUAs where the travel route dissected the VUA polygon. Figure C7 shows the relationship between the VUA points and the travel route. Given this final network it is important not to lose the original integrity of the original 4125 destination points from the survey for the final analysis and results. Since this is the most up to date information about recreation visitation in the Sound, an identity function was used in ArcMap to relate the original destination points (those that fell within each of the VUA boundaries) to one of the 152 points that are associated with each polygon and are on the topological network used in the simulation. Queries from the simulation could be done to summarize all 4125 points to answer the variety of spatial and temporal research questions outlined earlier.

Given that the travel network has a complete route that represents all possible travel patterns and all the original destinations from the travel diaries, trip Itineraries can now be constructed from survey data. Each trip itinerary has a travel mode, activity type, start and end data, travel destinations, trip durations, stay durations and number of visitor in the party. This information is subsequently used to construct each trip itinerary that will be scheduled and run at simulation execution time.

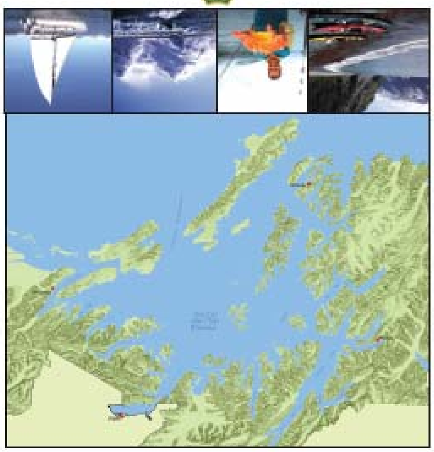
All spatial and temporal data are output from the simulation runs and queries built to extract and analyze the data.

Appendix D: Common names associated with Visitor Use Areas.

Name	VUA	Name	VUA	Name	VUA
Pigot Bay	1	Drier Bay	52	Campbell Bay	102
Surprise Cove	2	Copper Bay	53	Growler Bay	103
Cochrane Bay	3	Mummy Bay	54	Chamberlain Bay	104
Hummer Bay	4	Snug Harbor	55	Bull Head	105
Bettles Bay	5	Knight Island Passage	56	Columbia Bay	106
Hobo Bay	6	Hogan Bay	57	Heather Bay	107
Harrison Lagoon	7	Montague Strait	58	Finski Bay	108
Granite Bay 3	8	Hanning Bay	59	Port Valdez	109
Port Wells Passage	9	The Needle	60	Valdez Narrows	110
College Fiord	10	Rocky Bay	61	Fairmount Is	111
Eaglek Bay	11	Bay of Isles	62	Jack Bay	112
Esther Passage	12	Marsha Bay	63	Port Wells Passage	113
Shoestring Cove	13	Lower Herring Bay	64	Deep Bay	114
Squaw Bay	14	Smith Island	65	Orca Inlet	115
Dutch Group	15	Seal Island	66	Cordova	116
Axel Lind Island 1	16	Herring Bay	67	Simpson Bay	117
Lone Island	17	Louis Bay	68	Simpson Bay	118
Wells Passage	18	Northwest Bay	69	Bear Trap Bay	119
Lake Bay	19	Galena Bay	70	Parshas Bay	120
Fool Island	20	Siwash Bay	71	Port Gravina	121
Esther Bay	21	Eickelberg Bay	72	Point Gravina	122
Culross Passage	22	Valdez	73	Sunny Bay	123
Culross Bay	23	Tatitlek Bay	74	Whalen Bay	124
Hidden Bay	24	Reef Island	75	Two Moon Bay	125
Port Nellie Juan	25	Landlocked Bay	76	Hells Hole	126
McCluer Bay	26	Sheep Bay	77	Snug Corner Cove	127
Main Bay	27	Boswell Bay	78	Knowles Bay	128
Foul Bay	28	Gulf of Alaska…	79	Sawmill Bay	129
Falls Bay	29	Wooded Islands	80	Valdez Arm	130
Crafton Island	30	Gulf of Alaska…	81	Port Etches	131
Eschamy Bay	31	Resurrection Bay	82	Shelter Bay	132
Ewan Bay	32	Day Harbor	83	Anderson Bay	133
Pappy Bay	33	Axel Lind Island 2	84	Hawkins Island Cutoff	134
Nassau Fjord	34	Port Wells Passage	85	East Hawkins Island	135
Icy Bay	35	Fable Point	86	Central Hawkins Island	136
Whale Bay	36	Perry Island	87	Hinchinbrook	137
Jackpot Bay	37	Meares Point	88	Hinchinbrook	138
Jackpot Island	38	South Bay	89	Stockdale Harbor	139

Name	VUA	Name	VUA	Name	VUA
Dangerous Passage	39	Billings Point	90	Port Chalmers	140
Masked Bay	40	Cabin Bay	91	Green Island North	141
Granite Bay 2	41	Liljegren Passage	92	Little Green Island	142
Knight Island Passage	42	Storey Island	92	Barry Arm	143
Bainbridge Passage	43	McPherson Bay	93	Harriman Fjord	144
Hogg Bay	44	Naked Island	94	Harriman Fjord	145
Auk Bay	45	Wells Bay	95	Blackstone Bay	146
Procession Rocks	46	Cedar Bay	96	Passage Canal	147
South Twin Bay	47	Granite Bay 1	97	Port Wells	148
Iktua Bay	48	Fairmount Bay	98	Port Wells Passage	149
Crab Bay	49	Long Bay	99	Greystone Bay	150
Horseshoe Bay	50	Long Bay	100	Kings Bay	151
Port Crawford	51	Fairmount Bay	101	Perry Passage	152

Appendix E: Survey instrument with descriptive statistics included



Boating in

Prince William Sound

A Survey of Recreational and Subsistence Users

2

Prince William Sound Recreational and Subsistence Users

The Chugach National Forest is conducting this survey of boat users on Prince William Sound to gain information on the travel and resource use patterns of visitors and residents. With increasing access, recreational and personal use of the Sound is expected to grow substantially over the next several years and current use patterns will change. We are gathering information from recreational and subsistence users to improve our ability to protect and provide access to the Sound and maintain and improve the experience. Participation in the survey is completely voluntary and your responses will be kept confidential.

Instructions.

This questionnaire asks you to provide information about your recreation preferences and the experience of your most recent trip on the Sound. Several questions ask you to reflect on the experience and are best answered at the end of your trip. The survey is being conducted May-September, 2005. If you are a frequent visitor, you may be asked to take the survey more than once over the season, and we ask that you answer the questions only in regard to your most recent trip.

Your participation is especially important for the success of this study, and we thank you for your input.

A1. What is the primary purpose of your trip to the Sound (check all that apply)? Overall number of surveys = 573

- ☐ subsistence fishing, hunting, or gathering 14%
- ☐ recreation (including boating, sportfishing, hunting, etc.) 82%
- ☐ some other reason (please describe)____ 8%____

A2. Are you a resident of Alaska?

☐ yes 85% ☐ no 14%

If no, how many times have you visited Alaska for recreation?

- ☐ This is my first visit 3%
- ☐ 1-5 5%
- ☐ 6-10 4%
- ☐ 11 or more 5%

A3. Is this your first boating trip on the Sound?

☐ yes 12% ☐ no 87%

If you answered "no", when was your first boating trip on the Sound? ______/______ month year

About how many days do you spend boating on the Sound in a year? ________days per year

A4. Since leaving home on this trip, has Prince William Sound been your only destination, the primary destination, or just one destination out of several with equal or greater importance?

- ☐ Only destination 71%
- ☐ Primary destination 16%
- ☐ One of several destinations 12%

A5. What was your point of entry into Prince William Sound?

- ☐ Whittier/Anchorage 69%
- ☐ Seward 1%
- ☐ Homer 0%
- ☐ Cordova 5%
- ☐ Valdez 25%
- ☐ Other ________ 1%

A6. What is the starting date of this trip on the Sound?

______/______, 2005 month day

A7. What is the end date of this trip on the Sound?

______/______, 2005 month day

5

C2. Fueling facilities within the Sound are currently limited to those in the harbors at Whittier, Valdez and Cordova. How would your use of the Sound change if one new fueling station was available in the southwestern area of the Sound, 60-80 sea miles from Whittier (check all that apply)?

- ☐ Use the fuel station(s) to extend my 37%
- ☐ Avoid areas near fueling stations 14%
- ☐ Visit the Sound more often 14%
- ☐ Visit the Sound less often 4%
- ☐ Would not change my use of the Sound 42%
- ☐ Other (please describe) ___ 11%

Finally, to make sure that the group of people we reach with this survey are representative of Prince William Sound visitors and users, we need to ask some questions about you. Again, your answers will be kept anonymous and no individual responses will be reported when the survey results are documented.

D1. About how much time in total will you be away from home on this trip? ________days

D2. About how much money do you spend in a typical year on recreation or subsistence activities, including travel, equipment, memberships and licenses? $________/year

D3. For this trip, are you: 36%

- ☐ sharing expenses with other people on the trip
- ☐ paying just your own expenses 23%
- ☐ paying for yourself and _____others 30%
- ☐ someone else is paying your expenses 4%

D4. For the following categories, please report the amount that you spent on this trip (only report the amount that you have spent personally or that has been paid for you personally):

- ________ government owned lodging
- ________ privately owned lodging
- ________ food/drink at restaurants and bars
- ________ gasoline and oil
- ________ other transportation
- ________ activities, guide fees, and equip. rentals
- ________ recreation use fees
- ________ souvenirs
- ________ other (describe)________

D5 What is your zip code? ____________

D6. How many people, other than yourself, traveled here in the same vehicle as you? ________people

How many of those people are less than 18 years old? ________people

D7. Are you male or female?

☐ Male 70% ☐ Female 25%

D8. What is your race/ethnicity?

- ☐ Black/African American 0%
- ☐ Asian 0%
- ☐ White 87%
- ☐ American Indian/Alaska Native 2%
- ☐ Native Hawaiian or other Pacific Islander 0%
- ☐ Spanish, Hispanic, or Latino 1%
- ☐ Other 3%

D9. What is your annual household income?

- ☐ less than $10,000 0%
- 6% ☐ $60,000 to $69,000
- ☐ $10,000 to $19,000 1%
- 0% ☐ $70,000 to $79,000
- ☐ $20,000 to $29,000 2%
- 0% ☐ $80,000 to $89,000
- ☐ $30,000 to $39,000 4%
- 7% ☐ $90,000 to $99,000
- ☐ $40,000 to $49,000 4%
- 24% ☐ $100,000 to $149,000
- ☐ $50,000 to $59,000 8%

☐ $150,000 or more 13%

Comments?

cruisers

3 Cruising Insert N= 176*

A8. Please identify the primary activities that were the main purpose of your trip. Also identify activities that you participated in but were not the primary purpose for your visit (check all that apply). n=175

primary activity	participated			
o	o	Motorized boating	68%	28%
o	o	Non-motorized boating	9%	11%
o	o	Primitive camping	5%	3%
o	o	Overnight stay in cabin or lodge	5%	3%
o	o	Overnight mooring/anchorage in remote locations	38%	16%
o	o	Viewing natural features such as glaciers and other scenery	37%	46%
o	o	Visiting historic or prehistor	2%	7%
o	o	Birdwatching	10%	32%
o	o	Whalewatching	9%	25%
o	o	Viewing bears	8%	22%
o	o	Viewing other wildlife	16%	50%
o	o	Nature study	3%	6%
o	o	Fishing - saltwater	44%	25%
o	o	Fishing - freshwater	1%	2%
o	o	Sport hunting	6%	4%
o	o	Hiking or walking	11%	23%
o	o	Backpacking	1%	2%
o	o	Picnicking and family	9%	7%
o	o	Gathering natural forest products such as berries for personal use	5%	14%
o	o	Other (please describe)	9%	5%

_____

A9. What types of boats did you use on this trip? Check off the primary type and other types used on this trip.

primary vessel	secondary vessel			
o	o	runabout A9 n=174	16%	3%
o	o	open skiff	7%	6%
o	o	cabin cruiser	45%	1%
o	o	motor yacht	7%	1%
o	o	sailboat	11%	0%
o	o	commercial or water taxi	2%	1%
o	o	inflatable	6%	26%
o	o	sea kayak	3%	10%
o	o	jet ski	2%	0%
o	o	commercial fishing: type	3%	0%
		_____		
o	o	other: __	2%	3%

10. Did you use a commercial guide service on this trip?

o yes 3% o no 95%
A10 n=173

*All percentages calculated based on this number

A11. Did you use a transportation service to reach a destination in the Sound (check all that apply)?

o	no service used A11 n=172	94 %
o	ferry	2%
o	air taxi	0%
o	water taxi/charter boat	1%
o	cruise ship	0%
o	other (please describe)	1%

_____ _____

A12. In the table below, please rate the **importance** of the following features of your trip to the Sound on the quality of your experience **(1= very important; 5=not important)**. Also rate **your satisfaction** with the condition of these features **(1=very satisfied, 5=very unsatisfied)**. Leave blank if the feature does not apply to your trip.

Importance Rating: very important				not important	site characterisitc	Satisfaction Rating: very satisfied				very unsatisfied
o 1	o 2	o 3	o 4	o 5	motorized users within sight and sound at overnight use sites	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	nonmotorized users within sight and sound at overnight use sites	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	motorized users within sight and sound at day-use sites	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	nonmotorized users within sight and sound at day-use sites	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	lack of fueling facilities	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	lack of mooring buoys	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	litter at onshore sites	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	human waste at onshore sites	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	wilderness experience	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	availability of cabins	o 1	o 2	o 3	o 4	o 5

Comments: Are there any additional characterisitcs of sites that you visited that you would like to comment on?_____
_____
_____

Now, please go to the large foldout map and complete the "Mapping Your Trip" section. After completing the map section, please return to the questions on Page 4 on the back of this sheet.

B1. n = 163 About the site you marked **'P1'** in the "Mapping Your Trip" section:

What was the purpose of your visit to this site?

- o onshore sightseeing/hiking 16%
- o offshore sightseeing 27%
- o onshore camping 8%
- o overnight anchorage 32%
- o other 30%

How many nonmotorized boats/groups did you see there?

o none 56% o 1-3 22% o 4 or more 15%

How many other motorized boats/groups did you see there?

o none 23% o 1-3 41% o 4 or more 28%

On a scale of one to nine, was this site very crowded or not crowded at all (check one response)?

1	2	3	4	5	6	7	8	9
extremely crowded		somewhat crowded			moderately crowded			not at all crowded

How many boats/groups would you be willing to see and still go there? _____ boats/groups

Would you travel to this site if it had required an additional 1/2 hour of boat travel on the day the you arrived there? o yes 77% o no 11%

B2. At the site you marked **'P2'** in the previous mapping question (Question 14):

What was the purpose of your visit to this site?

- o onshore sightseeing/hiking 14%
- o offshore sightseeing 23%
- o onshore camping 5%
- o overnight anchorage 28%
- o other_____ 25%

How many nonmotorized boats/groups of did you see there?

o none 45% o 1-3 19% 4 or more 9%

How many motorized boats/groups did you see there?

o none 20% o 1-3 36% 4 or more 18%

On a scale of one to nine was this site very crowded or not crowded at all (check one response)?

1	2	3	4	5	6	7	8	9
extremely crowded		somewhat crowded			moderately crowded			not at all crowded

How many boats/groups would you be willing to see and still go there? _____ boats/groups

Would you travel to this site if it had required an additional 1/2 hour of boat travel on the day the you arrived there? o yes 64% o no 9%

4 Cruising insert N= 176

In each of the next two questions are two alternative sets of site features. Please consider how you would trade off the different features of the sites offered and check off the one you would most prefer.

B3. Consider the features of the two **overnight use sites** described below. If you had travelled to your intended overnight use site and found it fully occupied, which of these sites would you choose as an alternative. Select only Site A *or* Site B.

o Site A	o Site B
• 1 hour of boat travel to reach the site • 3 parties of other users Moorage available	• 1/2 hour of boat travel to reach the site • No other groups of users • No moorage available

B4. Consider the features of the **day use sites** described below. If you had travelled to your intended site and found it fully occupied, which of these sites would you choose as an alternative. Select only Site A *or* Site B.

o Site A	o Site B
• 1/2 hour of boat travel • No parties of other users • Tidewater glaciers	• 1 hour of boat travel • 10 other groups of users • 90% chance of viewing wildlife within 100 feet

Access to Prince William Sound

Changes in access to the Sound continue to make visiting and travelling on the Sound easier and more affordable for many people. We are interested in how you anticipate your use of the Sound will change with changing access conditions.

C1.n=115 The Alaska Marine Highway System begins high ferry service and more frequent ferry passage between Whitter, Cordova, Valdez, and Seward in summer of 2005. Which of the following describes your plans for use of the ferry with increased speed and frequency of service. **Check all that apply.**

- o travel to Whittier more often 11%
- o travel to Cordova more often 27%
- o travel to Valdez more often 15%
- o travel to other location more often 3%
- o use the ferry more on weekends 9%
- o use the ferry more on weekdays 4%
- o use the ferry to reach less crowded 4%
- o trailer my boat on the ferry more often 7%
- o relocate storage of my boat 1%
- o **other** (please describe) 29%

Fisher/Hunter Insert N=434*

A8. Please identify the primary activities that were the main purpose of your trip. Also identify activities that you participated in but were not the primary purpose for your visit (check all that apply). n=430

primary activity	participated		primary	participated
o	o	Saltwater fishing from shore	2%	7%
o	o	Saltwater fishing from a	81%	25%
o	o	Freshwater fishing from shore	3%	1%
o	o	Freshwater fishing from a boat	1%	1%
o	o	Bear hunting	4%	5%
o	o	Deer hunting	2%	3%
o	o	Other hunting ___	0%	1%
o	o	Trapping	0%	0%
o	o	Primitive camping	5%	5%
o	o	Overnight stay in public	2%	2%
o	o	Overnight stay in private cabin or lodge	1%	0%
o	o	Overnight stay on boat	20%	14%
o	o	Viewing natural features such as glaciers and other scenery	18%	42%
o	o	Viewing wildlife	18%	43%
o	o	Nature study	1%	15%
o	o	Hiking or walking	3%	15%
o	o	Picnicking and family day	3%	7%
o	o	Gathering natural forest products such as berries (personal use)	2%	7%
o	o	Other (please describe) __	11%	7%

If you identified hunting, fishing, or gathering activities above, were they primarily for sub-sistence, personal use, or recreational/sport purposes?

o	primarily sport	38 %
o	primarily personal use	57%
o	primarily subsistence	8%

A9. What types of boats did you use on this trip? Check off the primary type and other types used on this trip. n=428

primary vessel	secondary vessel		primary	secondary
o	o	runabout	21%	2%
o	o	open skiff	17%	3%
o	o	cabin cruiser	43%	4%
o	o	motor yacht	4%	0%
o	o	sailboat	1%	0%
o	o	commercial or water taxi	1%	0%
o	o	inflatable	3%	14%
o	o	sea kayak	1%	3%
o	o	jet ski	0%	0%
o	o	commercial fishing: type_	3%	0%
o	o	other: ___	5%	1%

If you used a motorized boat, what is your running speed?_____

A10. Did you use a commercial guide service on this trip? n=423

o yes 6% o no 92%

* All percentages calculated based on this number

A11. Did you use a transportation service to reach a destination in the Sound (check all that apply)? n=422

o	no service used	89%
o	ferry	1%
o	air taxi	0%
o	water taxi/charter boat	3%
o	cruise ship	0%
o	other (please describe) __	3%

A12. In the table below, please rate the **importance** of the following features of your trip to the Sound on the quality of your experience **(1= very important; 5=not important)**. Also rate **your satisfaction** with the condition of these features **(1=very satisfied, 5=very unsatisfied)**. Leave blank if the feature does not apply to your trip.

Importance Rating (very important 1 2 3 4 5 not important)	features	Satisfaction Rating (very satisfied 1 2 3 4 5 very unsatisfied)
o o o o o	hunting or fishing harvest limit	o o o o o
o o o o o	fishing catch rate	o o o o o
o o o o o	hunting success	o o o o o
o o o o o	availability of mooring facilities/buoys	o o o o o
o o o o o	availability of fueling facilities	o o o o o
o o o o o	number of other users within site and sound at overnight sites	o o o o o
o o o o o	number of recreational boaters at day use sites	o o o o o
o o o o o	number of hunters at day use sites	o o o o o
o o o o o	number of noncommercial fishers at day use sites	o o o o o
o o o o o	number of commercial fishing boats	o o o o o
o o o o o	availability of cabins	o o o o o
o o o o o	absence of developed campsites	o o o o o
o o o o o	litter/waste at onshore sites	o o o o o
o o o o o	wilderness experience	o o o o o

Comments: Are there any additional characterisitcs of sites that you visited that you would like to comment on?_____

Now, please go to the large foldout map and complete the "Mapping Your Trip" section. After completing the map section, please return to the questions on Page 4 on the back of this sheet.

B1. About the site you marked **'P1'** in the "Mapping Your Trip" section: n=397

What was the purpose of your visit to this site?

- o hunting/fishing 62%
- o onshore camping 7%
- o other _____ 28%

How many other boats/groups of hunters or fishers did you see there?

o none 18% 1-3 40% 4 or more 34%

How many other boats/groups of other types of visitors did you see there?

o none 32% 1-3 27% 4 or more 27%

On a scale of one to nine, was this site very crowded or not crowded at all (check one response)?

1	2	3	4	5	6	7	8	9
extremely crowded		somewhat crowded			moderately crowded			not at all crowded

How many boats/groups would you be willing to see and still go there? _____ boats/groups

Would you travel to this site if it had required an additional 1/2 hour of boat travel on the day the you arrived there? o yes 72% o no 13%

B2. At the site you marked **'P2'** in the previous mapping question (Question 14): n=333

What was the purpose of your visit to this site?

- o hunting/fishing 57%
- o onshore camping 2%
- o other _____ 21%

How many other boats/groups of hunters or fishers did you see there?

o none 18% 1-3 35% 4 or more 21%

How many other boats/groups of other types of visitors did you see there?

o none 29% 1-3 24% 4 or more 19%

On a scale of one to nine was this site very crowded or not crowded at all (check one response)?

1	2	3	4	5	6	7	8	9
extremely crowded		somewhat crowded			moderately crowded			not at all crowded

How many boats/groups would you be willing to see and still go there? _____ boats/groups

Would you travel to this site if it had required an additional 1/2 hour of boat travel on the day the you arrived there? o yes 60% o no 12%

In each of the next two questions are two alternative sets of site features. Please consider how you would trade off the different features of the sites offered and check off the one you would most prefer.

B3. Consider the features of the two **overnight use sites** described below. If you had travelled to your intended overnight use site and found it fully occupied, which of these sites would you choose as an alternative. Select only Site A *or* Site B.

o Site A	o Site B
• 1 hour of boat travel to reach the site • 3 parties of other users • Primitive camping • No additional cost per person	• 1/2 hour of boat travel to reach the site • No other groups of users • Cabin available • $100 additional cost per person

B4. Consider the features of the two **fishing or hunting sites** described below. If you had travelled to your intended site and found it fully occupied, which of these sites would you choose as an alternative. Select only Site A *or* Site B.

o Site A	o Site B
• 1/2 hour of boat travel • No parties of other users • 20% chance that you harvest your limit of targeted species • No additional cost per person	• 1 hour of boat travel • 10 other groups of users • 90% chance that you harvest your limit of targeted species • No additional cost per person

Access to Prince William Sound

Changes in access to the Sound continue to make visiting and travelling on the Sound easier and more affordable for many people. We are interested in how you anticipate your use of the Sound will change with changing access conditions.

C1. The Alaska Marine Highway System begins high speed ferry service and more frequent ferry passage between Whitter, Cordova, Valdez, and Seward in summer of 2005. Which of the following describes your plans for use of the ferry with increased speed and frequency of service. **Check all that apply. n202**

- o travel to Whittier more often 10%
- o travel to Cordova more often 16%
- o travel to Valdez more often 11%
- o travel to other location more often_
- o use the ferry more on weekends 5%
- o use the ferry more on weekdays 6%
- o use the ferry to reach less crowded 7%
- o trailer my boat on the ferry more often 7%
- o relocate storage of my boat 2%
- o other (please describe)___ 31%

_____

paddlers

3 Paddler insert N=59*

A8. Please identify the primary activities that were the main purpose of your trip. Also identify activities that you participated in but were not the primary purpose for your visit (check all that apply).n=59

primary activity	participated			
o	o	Motorized boating	12%	25%
o	o	Non-motorized boating	87%	8%
o	o	Primitive camping	50%	13%
o	o	Overnight stay in cabin or	12%	5%
o	o	Overnight mooring/anchorage in remote locations	10%	10%
o	o	Viewing natural features such as glaciers and other scenery	67%	25%
o	o	Visiting historic or prehistori	3%	7%
o	o	Birdwatching	22%	45%
o	o	Whalewatching	18%	27%
o	o	Viewing bears	17%	32%
o	o	Viewing other wildlife	28%	47%
o	o	Nature study	15%	12%
o	o	Fishing - saltwater	15%	17%
o	o	Fishing - freshwater	3%	8%
o	o	Sport hunting	2%	0%
o	o	Hiking or walking	20%	33%
o	o	Backpacking	2%	3%
o	o	Picnicking and family	5%	10%
o	o	Gathering natural forest products such as berries for personal use	10%	10%
o	o	Other (please describe) _	13%	7%

A9. n=58 What tyj boats did you use on this trip? Check off the primary type and other types used on this trip.

primary vessel	secondary vessel			
o	o	runabout	0%	2%
o	o	open skiff	3%	3%
o	o	cabin cruiser	8%	3%
o	o	motor yacht	0%	0%
o	o	sailboat	2%	0%
o	o	commercial or water taxi	5%	22%
o	o	inflatable	3%	2%
o	o	sea kayak	83%	7%
o	o	jet ski	0%	0%
o	o	commercial fishing: type	0%	0%
o	o	other: _____	0%	0%

A10.n= 58 Did you use a commercial guide service c trip?

o yes 10% o no 90%

* All caclations based on this number

A11. n=58 Did you use a transportation service to re destination in the Sound (check all that apply)?

o	no service used	48%
o	ferry	7%
o	air taxi	2%
o	water taxi/charter boat	43%
o	cruise ship	0%
o	other (please describe)	8%

A12. In the table below, please rate the **importance** of the following features of your trip to the Sound on the quality of your experience **(1= very important; 5=not important)**. Also rate **your satisfaction** with the condition of these features **(1=very satisfied, 5=very unsatisfied)**. Leave blank if the feature does not apply to your trip.

Importance Rating very important				not important	site characterisitc	Satisfaction Rating very satisfied				very unsatisfied
o 1	o 2	o 3	o 4	o 5	motorized users within sight and sound at overnight use sites	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	nonmotorized users within sight and sound at overnight use sites	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	motorized users within sight and sound at day-use sites	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	nonmotorized users within sight and sound at day-use sites	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	lack of fueling facilities	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	vegetation loss at onshore sites	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	litter at onshore sites	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	human waste at onshore sites	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	wilderness experience	o 1	o 2	o 3	o 4	o 5
o 1	o 2	o 3	o 4	o 5	availability of cabins	o 1	o 2	o 3	o 4	o 5

Comments: Are there any additional characterisitcs of sites that you visited that you would like to comment on?_____

Now, please go to the large foldout map and complete the "Mapping Your Trip" section. After completing the map section, please return to the questions on Page 4 on the back of this sheet.

4 Padder insert N=59*

B1.n=54 About the site you ma **'P1'** in the "Mapping Your Trip" section:

What was the purpose of your visit to this site?

- o onshore sightseeing/hiking 30%
- o offshore sightseeing 32%
- o onshore camping 40%
- o overnight anchorage 2%
- o other 20%

How many nonmotorized boats/groups did you see there?

o none 30% o 1-3 42% o 4 or more 22%

How many motorized boats/groups did you see there?

o none 35% o 1-3 7% o 4 or more 32%

On a scale of one to nine, was this site very crowded or not crowded at all (check one response)?

1	2	3	4	5	6	7	8	9
extremely crowded		somewhat crowded			moderately crowded			not at all crowded

How many boats/groups would you be willing to see and still go there? _____ boats/groups

Would you travel to this site if it had required an additional 1/2 hour of boat travel on the day the you arrived there? o yes 78% o no 7%

B2. At the site you marked **'P2'** in the previous mapping question (Question 14):

What was the purpose of your visit to this site?

- o onshore sightseeing/hiking 30%
- o offshore sightseeing 32%
- o onshore camping 40%
- o overnight anchorage 2%
- o other _____ 20%

How many nonmotorized boats/groups of did you see there?

o none 40% o 1-3 25% o 4 or more 20%

How many motorized boats/groups did you see there?

o none 33% o 1-3 30% o 4or more 23%

On a scale of one to nine was this site very crowded or not crowded at all (check one response)?

1	2	3	4	5	6	7	8	9
extremely crowded		somewhat crowded			moderately crowded			not at all crowded

How many boats/groups would you be willing to see and still go there? _____ boats/groups

Would you travel to this site if it had required an additional 1/2 hour of boat travel on the day the you arrived there? o yes 73% o no 10%

In each of the next two questions are two alternative sets of site features. Please consider how you would trade off the different features of the sites offered and check off the one you would most prefer.

B3. Consider the features of the two **overnight use sites** described below. If you had travelled to your intended overnight use site and found it fully occupied, which of these sites would you choose as an alternative. Select only Site A ***or*** Site B.

o Site A	o Site B
• 1/2 hour of boat travel to reach the site • 3 parties of other visitors • Primitive camping • No additional cost per person	• 1-1/2 hours of boat travel to reach the site • No other groups of visitors • Cabin • $200 additional cost per person

B4. Consider the features of the **day use sites** described below. If you had travelled to your intended site and found it fully occupied, which of these sites would you choose as an alternative. Select only Site A *or* Site B.

o Site A	o Site B
• 1 hour of paddling travel • No ferry or taxi travel • No parties of other visitors • Tidewater glacier • No additional cost per person	• 1/2 hour of paddling travel • 6 hours of ferry or taxi travel • 10 other groups of visitors • 90% chance of viewing wildlife within 100 feet • $100 additional cost per person

Access to Prince William Sound

Changes in access to the Sound continue to make visiting and travelling on the Sound easier and more affordable for many people. We are interested in how you anticipate your use of the Sound will change with changing access conditions.

C1.n= 47 The Alaska Marine Highway System begins high s ferry service and more frequent ferry passage between Whitter, Cordova, Valdez, and Seward in summer of 2005. Which of the following describes your plans for use of the ferry with increased speed and frequency of service. **Check all that apply.**

- o travel to Whittier more often 10%
- o travel to Cordova more often 15%
- o travel to Valdez more often 10%
- o travel to other location more often 8%
- o use the ferry more on weekends 5%
- o use the ferry more on weekdays 3%
- o use the ferry to reach less crowded areas 13%
- o trailer my boat on the ferry more often 3%
- o relocate storage of my boat 0%
- o **other** (please describe) ___ 60%